

STATUS OF HEAVY METALS IN SEA WATER OF APARRI, CAGAYAN, PHILIPPINES AND THE AWARENESS OF STAKEHOLDERS ON HEAVY METAL CONTAMINATION AND INTOXICATION

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Abstract:

This study aimed to assess the status of heavy metals (Cadmium and Arsenic) in the seawater of Aparri, Cagayan and the awareness of respondents- fisherfolks and implementors (BFAR and DENR personnel)- towards heavy metal contamination and intoxication. The level of Cadmium and Arsenic were measured in seawater samples taken from the seashore and at the fishing area using Graphite Furnace Atomic Absorption Spectroscopy. Close ended questionnaire was used in assessing the level of awareness of stakeholders towards heavy metal contamination and intoxication. The gathered results revealed that the water samples collected at the seashore and fishing area regardless of tidal status are contaminated with arsenic, while the fishing area is contaminated with cadmium during low tides only. When it comes to the level of awareness of respondents, the results revealed that they have moderate level of awareness when it comes to heavy metal contamination and intoxication. This implies that respondents are aware and can partially describe heavy metal contamination and intoxication. The results also revealed that age, educational attainment, average net monthly income and encumbered appliances have impact on the level of awareness of respondents towards the effects of heavy metal contamination while age, educational attainment, frequency of immersion to seawater, average net income, length of service and encumbered appliances have impact on the level of awareness of respondents towards the remediations on heavy metal contamination. Based from these findings, the researcher concluded that the seawater of Aparri is contaminated with Arsenic regardless of the site of collection and tidal status and Cadmium at the fishing area during low tides only. It was concluded further that respondents have a moderate level of awareness when it comes to heavy metal contamination and intoxication. Considering this, a program plan towards heavy metal contamination and intoxication control program was proposed for the municipality of Aparri, Cagayan. Based from this conclusion, the researcher recommends that implementing agencies shall intensify Information Education Campaign materials towards heavy metal contamination and intoxication and shall consider to continue the testing and monitoring of heavy metal contents of sea water and aquatic commodities.

Keywords: Heavy Metals, Heavy Metal Intoxication, Heavy Metal Contamination

Introduction

Philippines is comprised of large number of islands, making it as one of the largest island country in the world. As an archipelago, its coastal municipalities enjoy the vastness of the oceans and seas making it as a tourist spot for recreational activities like swimming, boating, and SCUBA diving. Since the country is known to be blessed with bounty of natural resources thriving in its bodies of water, fishing has become the source of livelihood to many Filipinos, especially those who are living in coastal areas (Philippine Statistics Authority, 2022).

In the past years, Filipinos have enjoyed the grandeur of the country's marine resources (aquatic commodities) for consumption and livelihood. As time advances, the methods of fishing employed by our fishermen upgrade with the use of technology. This advances in fishing techniques increased the yields of fishermen, but these innovations in the methods of fishing can permanently cause pollution threats to the bodies of waters. In Aparri, Cagayan, the Bureau of Fisheries and Aquatic Resources reported an incidence of illegal fishing through foreign fisher folks that were caught to have explosives in their fishing vessels. It was also

recorded that in 2011, 2013 and 2020, incidence of oil spill have taken place because of sunken cargo ships and shattered Chinese vessels used in the dredging projects in Aparri.

Other than improper fishing and oil spill, there are other abusive activities done in bodies of water that can cause serious repercussions to man, As observed in the coastal municipality of Aparri, some of these activities include dredging, poor waste management and poor sewage system. Pollution to bodies of water may also be attributed to human and recreational activities done like swimming, SCUBA diving, camping near the seashore. Undeniably, these are potential cause of pollutions that may threaten our bodies of waters. Waste products from these anthropogenic sources can significantly pollute the marine waters.

Briffa et al. (2019) described that heavy metals are major pollutants in the environment. These metal contaminants can be mixed in the aquatic system through smelting process, effluents, sewage and leaching of garbage which cause severe harm to the aquatic system. Once it has contaminated the aquatic resources, heavy metals can be adsorbed or inhaled by man when comes in contact with contaminated bodies of water. Heavy metals can also be accumulated in fish tissues and can cause harm to anybody who consumes it. These heavy metals bio-accumulate to man and can potentially cause cumulative health risk most especially when threshold for heavy metal tolerable concentration is surpassed. These cumulative health threats are not limited to heavy metal poisoning and multiple organ problems since it can also cause death especially when cases are mismanaged. The problem with heavy metal intoxication is that, people are always less cognizant about its deleterious effect to one's health considering that it takes time before a particular disorder manifest.

In this study, the researcher aimed to assess the level of awareness of stakeholder on heavy metal contamination and intoxication and the presence of heavy metals on the sea water of Aparri Cagayan. This emanates from the context that there are probable events that were observed to cause heavy metal contamination to bodies of water in Aparri, Cagayan. Furthermore, the personnel of the Bureau of Fisheries and Aquatic Resources and the Department of Environment and Natural Resources also attested that determination of heavy metal concentrations in sea water has always been taken for granted despite of its possible public health threats to us.

Hence, the result of this study will serve as a guide for the Bureau of Fisheries and Aquatic Resource and Department of Environment and Natural Resources on policy or program development towards heavy metal contamination and intoxication in order to address these emerging concerns in heavy contamination of sea waters

Statement of the Problem

Generally, this study aimed to assess the status of heavy metals in sea water of Aparri, Cagayan and determine the awareness of stakeholders on heavy metal contamination and intoxication.

Specifically, it sought to answer the following questions;

1. What is the level of heavy metal contamination in the sea water of Aparri, Cagayan considering;
 - a. Tidal Status
 - b. Site of sample collection
2. What is the profile of respondents in terms of:
 - a. Demographic Profile
 - a.1. Age
 - a.2. Sex
 - a.3. Marital Status
 - a.4. Number of seminars attended on Heavy Metal Contamination and Intoxication
 - a.5. Frequency of immersion to sea water
 - b. Socioeconomic Profile
 - b.1. Educational Attainment
 - b.2. Membership in Organizations
 - b.3. Average Net Monthly Income
 - b.4. Position
 - b.5. Length of Service
 - b.6. Encumbered Appliances for communication or Information
 - c. Clinical Profile
 - c.1. Current Ailment
 - c.2. Co-Morbidity

3. What is the level of awareness of respondents on Heavy Metal Contamination in terms of:
 - a. Causes
 - b. Effects
 - c. Remediations
4. What is the level of awareness of respondents on Heavy Metal Intoxication in terms of:
 - a. Pathophysiology
 - b. Signs and Symptoms
 - c. Prevention and Control
5. Is there a significant difference on the level of awareness of the respondents on Heavy Metal Contamination and Intoxication when grouped according to profile variables?

Methodology

In this study, surface water samples were collected in two different sampling sites in Aparri, Cagayan during high tide and low tide phenomenon. The first sample was collected at the seashore while the other sample was collected at the fishing area which is about 300 meters from the seashore. Sea water samples from the sea shore and fishing area were collected at different tidal status particularly early in the morning during low tide and at night when there is already a high tide.

About 500 ml of seawater specimens were collected at the sea shore and fishing area during low tide and high tide. Collected sea water samples were held in a screw capped tubes for transportation. Samples have undergone acid digestion and the level of heavy metals were measured through spectroscopy

When it comes to respondents, this study made use of simple random sampling wherein out of twenty five fisher folks residing in Brgy. Punta, there are only twenty of them who gave their consent voluntarily. As per to the implementors, there are only six out of eight administrative staff who were assigned on fishing regulations in BFAR and four out of six personnel were specialized in water quality management in the Environmental Management Bureau of the Department of Environment and Natural Resources.

Statistical Tool and Analysis

In analyzing the heavy metal concentration in sea water samples, results were compared to the threshold value taken from the Water Quality Guidelines and General Effluent Standard of the Department of Environment and Natural Resources- Environmental Management Bureau.

Site of Sample Collection	Arsenic	Cadmium
Seashore	0.01 mg/L	0.003 mg/L
Fishing Area	0.02 mg/L	0.005 mg/L

Figure 1. Threshold Value for the Analysis of Heavy Metal Contamination (DENR-EMB, 2016)

Frequency count and percentage distribution were used as a statistical tool to answer objective number two of this study. Mean was used to answer objective three and four. Figure four shows the four point scale that was used in the interpretation and discussion of responses from stakeholders

Mean Range	Descriptive Value	Interpretation
3.26-4.00	Extremely Aware	The respondent is aware of the statement parameter and can explain it very well
2.50-3.25	Moderately Aware	The respondent is aware of the statement parameter and can slightly explain it
1.75-2.49	Slightly Aware	The respondent is aware of the statement parameter but cannot explain it at all
1.00-1.74	Not Aware at all	The respondents is totally not aware of the statement parameter

Figure 2: Analysis of level of awareness for both Heavy Metal Contamination and Intoxication

For the test of association, Kruskal Wallis Test and Chi Square were used to determine if there is a significant difference on the level of awareness of respondents on heavy metal contamination in terms of causes

and heavy metal intoxication in terms of pathophysiology, signs and symptoms and prevention and control respectively when grouped according to age, marital status, number of seminars attended on heavy metal contamination and intoxication, frequency of immersion to sea water, educational attainment, average net monthly income, position, length of service, encumbered appliances, current ailment and commorbidity while Mann Whitney U Test was used to determine if there is a significant difference on the level of awareness of respondents on heavy metal contamination in terms of causes and heavy metal intoxication in terms of pathophysiology, signs and symptoms and prevention and control respectively when grouped according to sex and membership to organization..

When it comes to the test of association on the level of awareness of respondents on heavy metal contamination in terms of effects and remediation, one way ANOVA and T-test were used to analyze if there is a significant difference on the level of awareness of stakeholders on Heavy Metal Contamination and Intoxication when grouped according to profile variables.

RESULTS AND DISCUSSION

This chapter reveals the level of heavy metal in the sea water of Aparri, Cagayan and the responses of the different stakeholders about their awareness towards heavy metal contamination and intoxication.

The level of heavy metals in the sea waters of Aparri, Cagayan was assayed on samples collected at two different sites mainly at the seashore and at the fishing area which is about 300 meters from the seashore. The results revealed that regardless of the site of sample collection and tidal status, the level of arsenic is higher than the threshold value. The levels of arsenic measured which is 0.059mg/L at the sea shore during low tide and 0.052 mg/L during high tide are higher than the threshold value that is 0.01 mg/L of arsenic at the sea shore. The levels of arsenic that was also measured at the fishing area during low tide which is 0.370 mg/L and high tide which is 0.520 mg/L are higher than the threshold value that is 0.02 mg/L. These results imply that the water samples collected at the seashore and fishing area during low tide and high tide are contaminated with arsenic considering that the measured heavy metal concentrations are higher than the normal or threshold value. In the case of cadmium, the table below shows that 0.008 mg/L is detected at the fishing area during low tide. This is higher than 0.005 mg/L as the threshold value for cadmium at the fishing area. This implies that the fishing area is contaminated with cadmium during low tides considering that the measured concentration is higher than the threshold value or tolerable limit. However, the measured cadmium level at the seashore which is 0.00063 mg/L during low tide and 0.00160mg/L during high tide are relatively lower than 0.003 mg/L as threshold value. These results show that the level of cadmium at the seashore is within the threshold value or tolerable limit regardless of the tidal status.

As described by Elinder and Garup in their study in 1996, heavy metals can enter the marine environment through atmospheric depositions and when there is an introduction of waste water and communal or industrial discharges to bodies of water. Furthermore, heavy metals like arsenic and cadmium can be introduced to bodies of water during high tide especially when sea water tends to rise and reach a polluted sea shore or when flood extends to farmlands wherein it carries residual heavy metals from pesticides and fertilizers to the sea. In this case, cadmium and arsenic were distributed to the seawater even if the tidal status lowers already. However, cadmium has the potential to be accumulated easily to marine commodities since it is more soluble in water than that of arsenic which is known to be water insoluble. As a result, arsenic tends to remain longer in bodies of water than that of cadmium which can easily enter tissues of fishes and other aquatic commodities (Perera, 2016).

Table 1. Cross tabulation on the status of heavy metal contamination in Sea water of Aparri,Cagayan considering tidal status and site of sample collection

Tidal Status	Site of Sample Collection	ARSENIC			CADMIUM		
		Result (mg/L)	N.V. (mg/L)	Interpretation	Result (mg/L)	N.V. (mg/L)	Interpretation
Seashore	Low Tide	0.059	0.01	Contaminated	0.00063	0.003	Not Contaminated
	High Tide	0.052		Contaminated	0.00160		Not Contaminated
Fishing Area	Low Tide	0.370	0.02	Contaminated	0.00800	0.005	Contaminated
	High Tide	0.520		Contaminated	0.00022		Not Contaminated

The responses towards awareness on heavy metal contamination and intoxication were taken from stakeholders particularly the fisher folks and the implementors which were comprised of personnel from the Bureau of Fisheries and Aquatic Resources (BFAR) and the Department of Environment and Natural Resources (DENR). From these stakeholders, there were thirty respondents who voluntarily gave their consent in giving responses towards the study. Out from the thirty respondents, twenty of them were fisher folks from Aparri, Cagayan while six from the remaining ten respondents were personnel of BFAR and the other four respondents were from DENR.

Table 2.a. described the frequency count and percentage distribution of the profile of the respondents in terms of demography. In terms of the fisher folks, most of them belong to young adults that are between 18-49 years old. It was also noted that there were seven fisher folks who belong to the middle aged group. Out from these seven fisher folks, three of them have an age of 50-54 while four are above 55 years of age. In terms of the implementors, respondents from BFAR are young adults while most respondents from DENR are middle aged group.

As per to sex, generally, most of the respondents are male although in terms of the implementors there are more female respondents than the male. This accounts to the administrative staff of the Bureau of Fisheries and Aquatic Resources and the Department of Environment and Natural Resources. The two female fisher folks account to the wife and daughter of one of the respondent fisher folk.

Most of the respondents are married accounting to 76.67% while the remaining are single in terms of marital status. It can be also seen in the table that most of the respondents did not have any chance to attend seminars on heavy metal contamination and intoxication since this type of seminars have been underrated in the past years. In terms of the program implementors, there are only two of them who were able to attend to seminars on heavy metal contamination and intoxication. These two respondents account to the Chief Data Officer and chemical engineer working at the DENR and have been in service for a long time already.

As per to the frequency of immersion to sea water, fisher folk immerse themselves to sea water in a daily basis since it is the source of their livelihood. In addition, the two female fisher folks revealed also that they only immerse themselves to sea water at least once in a week when they assist in fishing. However, in terms of the implementors, they rarely immerse in sea water. In fact, nine of them claimed that they only immerse themselves to sea water once in a year when they do recreational activities. Although, one respondent from BFAR has a more frequent immersion to sea water since he conducts coral reef restoration and monitoring.

Table 2.a. Profile of the respondents in terms of demographic profile

	Frequency (N=30)			Percentage (%)
	Fisher folks	Implementors	Both	
Age				
18-24	1	2	3	10.0
25-29	4	1	5	16.67
30-34	6	0	6	20.00
35-39	1	1	2	6.67
40-44	1	3	4	13.33
45-49	0	0	0	0.00
50-54	3	3	6	20.00
Above 55	4	0	4	13.33
Sex				
Male	18	4	22	73.33
Female	2	6	8	26.67
Marital Status				
Single	4	3	7	23.33
Married	16	7	23	76.67

Number of seminars attended on Heavy Metal Contamination and Intoxication				
0	20	8	28	93.33
1-3	0	0	0	0.00
4-6	0	1	1	3.33
7-9	0	0	0	0.00
10-12	0	0	0	0.00
More than 12	0	1	1	3.33
Frequency of immersion to sea water				
Almost everyday	18	0	18	60.00
At least once in a week	2	0	2	6.67
At least once every two weeks	0	0	0	0.00
At least once every three weeks	0	0	0	0.00
Once a Month	0	0	0	0.00
Quarterly	0	1	1	3.33
Once a Year	0	9	9	30.00

Table 2.b. presents the frequency count and percentage distribution of the profile of the respondents in terms of socioeconomic profile. As it can be deduced from the table, only three out of twenty fisher folks were able to reach college level though only two of them were able to graduate because of financial issues. Despite of which, they opted to help in fishing for the mean time while waiting for better opportunities when it comes to livelihood. Both of them are young adults that are still waiting for employment opportunities. Majority of the fisher folks were not able to finish their studies and not even able to pursue college degree because of issues concerning financial stability in the family and accessibility of higher education institutions where they wish to study. As expected, respondents from BFAR and DENR are all college graduates, though, only five out of ten BFAR and DENR respondents were able to attain post graduate education. It is also noteworthy to highlight that only thirteen out of twenty fisher folks have a known membership to a cooperative particularly to the Pantawid Familyang Pilipino Program (4Ps). The other seven fisher folks, on the other hand, were not a member of any organization even to the 4Ps since they were not included as a beneficiary of it. In addition, out from the ten respondents of DENR and BFAR, there are about six of them who have themselves as members of their professional organizations. All respondents from DENR are enlisted as members to organizations while only two out of six respondents from BFAR have an updated membership to their professional organizations while the rest are yet to update their registrations this year.

In terms of average net monthly income, generally, the fisher folks are considered to be meager income earners with a net monthly income below 10,000.00 since they are just relying on fishing as their source of livelihood while there is one fisher folk that has an additional source of income through her small convenience store. In terms of the implementors, table 2.2. reveals that there are four staff from BFAR who have a net monthly income of 10,001-20,000.00 in a month. The three respondents that receive a net monthly income of 120,001-220,000.00 accounts to the agriculturist of BFAR that is in service for about 23 years already while the other two, on the other hand, are personnel of DENR for more than 25 years already. One of them is an environmental engineer and the other one is a Chief Data Officer.

When it comes to positions, three out of four respondents from DENR are environmental engineers while the other one is a Chief Data Officer. As described during the data collection, these environmental engineers are responsible in creating or developing solutions to environmental concerns such as pollutions in air, soil and water, unsafe drinking water and public health. They are also responsible in designing and implementing engineering solutions including that of water treatment, remediation and pollution control. Chief

Data Officers, on the other hand, are responsible in overseeing data related duties that covers data collection, data management, data analysis and creating valuable insights from data in order to improve and strengthen programs of the agency. As to respondents from BFAR, four of them are administrative staff while the other two accounts to the aquaculturist and Chief Fishing Regulation Officer. The Bureau of Fisheries and Aquatic Resources describes aquaculturist as champions in producing and cultivating aquatic commodities in a controlled conditions while Chief Fishing Regulation Officers are concerned in checking that fisher folks abide to the laws that govern proper methods of fishing in the Philippines.

In terms of length of service, fisher folks have, generally, engaged in full time fishing for about 10 years only, while majority of the implementors were already in service for more than fifteen years. The encumbered appliances of stakeholders have profound impact to them especially to the fisher folks since it served to be their major source of information when it comes to information, education materials that have something to do with the different aspects of human life.

Table 2.b. Profile of the respondents in terms of socioeconomic profile

	Frequency (N=30)			Percentage
	Fisher folks	Implementors	Both	(%)
Educational Attainment				
No Formal Education	0	0	0	0.00
Pre-School Graduate	0	0	0	0.00
Elementary Undergraduate	1	0	1	3.33
Elementary Graduate	6	0	6	20.00
High School Undergraduate	5	0	5	16.67
High School Graduate	5	0	5	16.67
College Undergraduate	1	0	1	3.33
College Graduate	2	5	7	23.33
Post Graduate Degree Holder	0	5	5	16.67
Membership in Organizations				
Yes	13	6	19	63.33
None	7	4	11	36.67
Average Net Monthly Income				
Below 10,000	19	0	19	63.33
10,001-20,000	1	4	5	16.67
20,001-40,000	0	0	0	0.00
<i>Continuation of Table 2.2.</i>				
40,001-80,000	0	1	1	3.33
80,001-120,000	0	2	2	6.67
120,001-220,000	0	3	3	10.00
Position				
DENR Personnel				
Chief Data Officer	0	1	1	3.33

Environmental Engineer	0	3	3	10.00
BFAR Personnel				
Staff	0	4	4	13.33
Chief Fishing Regulatory Officer	0	1	1	3.33
Aquaculturist	0	1	1	3.33
Fisherfolks	20	0	20	66.67
Length of Service				
Less than 1 year	2	0	2	6.67
1 year and 1 day-2 Years	1	0	1	3.33
2 Years and 1 day to 5 years	5	3	8	26.67
5 Years and 1 day to 10 years	7	1	8	26.67
10 Years and 1 day to 15 years	5	0	5	16.67
15 Years and 1 day to 25 years	0	4	4	13.33
More than 25 years	0	2	2	6.67
Encumbered Appliances				
Television Only	1	0	1	3.33
Radio Only	3	0	3	10.00
Both Television and Radio	16	10	26	86.67

Table 2.c. presents the frequency count and percentage distribution of the profile of the respondents in terms of clinical profile. As per to fisher folks, though they gave multiple responses, there are twelve out of twenty fisher folks who have current ailments in the past two years. Out of four fisher folks that have respiratory diseases, three of them were recorded to have asthma while the other one has Chronic Obstructive Pulmonary Disease. Out from the six fisher folks that were recorded to have cardiovascular and blood disorder, four of them were recorded to have heart failure while the other two have heart muscle disease and deep vein thrombosis respectively. When it comes to gastrointestinal diseases, two out of three fisher folks that have this disease were diagnosed to have peptic ulcer while the other one has mild internal hemorrhoid. There is one respondent that was diagnosed to have lower urinary tract infection. The respondents that have underlying cutaneous diseases were reported to have fungal infections. In terms of the implementors, three of them were noted to have cardiovascular and blood disorder. Two out from the three implementors were currently having a medical maintenance due to Coronary Artery Disease. There were fifteen stakeholders that were recorded not to have any disease in the past two years. Eight of them were fisher folks while the remaining are implementors.

Table 2.c. Profile of the respondents in terms of clinical profile

	Frequency (N=30)			Percentage (%)
	Fisherfolks	Implementors	Both	
Current Ailment				
Respiratory Disorders	4	0	4	13.33
Cardiovascular and Blood Disorder	6	3	9	30.0
Gastrointestinal Tract Diseases	3	0	3	10.0
Genitourinary Tract Diseases	1	0	1	3.33
Cutaneous Disorders	7	0	7	23.33
None	8	7	15	50

Comorbidity				
Hypertension	6	2	8	26.67
Diabetes Mellitus	4	3	7	23.33
Allergies	8	0	8	26.67
None	8	5	13	43.33

*Multiple Responses

Level of Awareness of Stakeholders on Heavy Metal Contamination of Sea of Aparri, Cagayan

Table 3.a. discusses the level of awareness of respondents on the causes of heavy metal contamination on bodies of water. The categorical mean is 2.96 with a descriptive value of moderately aware. This means that even if stakeholders, namely fisher folks and implementors are aware of the causes of heavy metal contamination to sea water, they still find difficulties in explaining or discussing it to others. This is attributed to the account of the respondents that they get their information about heavy metal contamination on bodies of water from reports given over the radio or television. It could be also seen that while implementors are highly aware (with a categorical mean of 3.38) about the causes of heavy metal contamination, fisher folks have level of awareness with a categorical mean of 2.74 and a descriptive value of moderately aware. This implies that implementors know and can discuss very well the causes of heavy metal contamination to sea water of Aparri, Cagayan while fisher folks could hardly explain it despite knowing the possible causes of heavy metal contamination.

Moreover, both fisher folks and implementors have low level of awareness when it comes to statement, Urbanization in Aparri facilitates heavy metal contamination of sea water, with a mean value of 1.80 and a descriptive value of slightly aware. This reveals that respondents may be wary about the role of urbanization in heavy metal contamination, but they can hardly discuss that there is urbanization in Aparri, Cagayan that may contribute to the contamination of sea water with heavy metals. Furthermore, stakeholders are moderately aware on the following statement parameters (Recreational activities like swimming contribute to heavy metal contamination of sea water with a mean value of 2.60; Human activities like fishing contribute to heavy metal contamination of sea water with a mean value of 2.87; Dynamite fishing introduces toxic substance such as heavy metals in the bodies of water with a mean value of 2.93; Dredging disturb sea sediments causing accumulation of heavy metals to bodies of water with a mean value of 2.93; Oil spill is a possible cause of heavy metal contamination to bodies of water with a mean value of 2.73) as possible causes of heavy metal contamination to bodies of water. This means that stakeholders are aware and can partially discuss the role of recreational activities, fishing, dredging and oil spill in contaminating bodies of water with heavy metals considering that implementors come to know about it because of their studies and trainings while fisher folks account their knowledge from their radio and television.

Respondents were also recognized to have high level of awareness on statement parameters (Open site dumping near the bodies of waters in Aparri causes heavy metal contamination in the Sea water of Aparri, Cagayan with a mean value of 3.60; Heavy metal residue in garbage can be carried over by flash floods to bodies of water causing heavy metal contamination with a mean value fo 3.57; Heavy metal residues of pesticides and fertilizers can be washed by flash floods into bodies of water with a mean value of 3.57) as leading cause of heavy metal contamination to bodies of water. This implies that respondents know and can describe and discuss very well how residues of heavy metals from open site dumping, farmlands and garbage can contaminate sea waters of Aparri, Cagayan.

Fisher folks have a poor level of awareness when it comes to statement, urbanization in Aparri facilitates heavy metal contamination of sea water. It has a mean value of 1.60 with a descriptive value of unaware. It means that fisher folks do not know the role of urbanization in heavy metal contamination to sea water. As they described during the interview, they do not pay much concern about the increase in population in Aparri and its effect to the environment considering that they spend most of their time in a day fetching aquatic commodities as a source of their livelihood. Moreover, fisher folks were also noticed to have level of awareness described as slightly aware when it comes to statement parameters (Recreational activities like swimming contribute to heavy metal contamination of sea water with a mean value of 2.35 and Oil spill is a possible cause of heavy metal contamination to bodies of water with a mean value of 2.35). This means that even if fisher folks know that recreational activities and oil spill can contribute to heavy metal contamination to bodies of water,

they still find difficulties in discussing on how can it happen considering that they have a limited source of information about heavy metal contaminations to the environment. It can be also deduced from the table below that fisher folks have high level of awareness when it comes to statement parameters (Open site dumping near the bodies of waters in Aparri causes heavy metal contamination in the Sea water of Aparri, Cagayan with a mean value of 3.40; Heavy metal residue in garbage can be carried over by flash floods to bodies of water causing heavy metal contamination with a mean value of 3.55; Heavy metal residues of pesticides and fertilizers can be washed by flash floods into bodies of water with a mean value of 3.50). This means that fisher folks knew and can explain very well how can open site dumping and residues from pesticides, fertilizers and garbage are potential source of heavy metal contamination to bodies of water. Fisher folks described that in 2019, there was a report of open site dumping in Aparri where garbage are improperly disposed near the bodies of water. Flash flood may bring these residues from this garbage to bodies of water. Fisher folks are also wary that farming is another form of livelihood done in Aparri, Cagayan wherein farmers utilize pesticides and fertilizers to cultivate their crops. Green and Hayes described in 1981 that fertilizers and pesticides contain trace amount of heavy metals as impurities, which after continued application may significantly increase its content in the soil. This heavy metal residues from fertilizers and pesticide may be carried to bodies of water through floods and irrigation system where farmers often wash their farming tools and machineries that have been previously contaminated with heavy metal containing products (McLaughlin et al.,2000).

In terms of the implementors, they have low level of awareness when it comes to statement, urbanization in Aparri facilitates heavy metal contamination of sea water, that has a mean value of 2.20 with a descriptive value of slightly aware. This means that even if they know that urbanization contributes to heavy metal contamination, they are still hesitant when it comes to urbanization in Aparri, Cagayan considering that implementors from BFAR and DENR described that they do not frequently visit Aparri, Cagayan making them less acquainted with the place so as with the rapid urbanization that is taking place there in the past years.

The implementors, however, have high level of awareness towards statements (Human activities like fishing contribute to heavy metal contamination of sea water with a mean value of 3.40; Open site dumping near the bodies of waters in Aparri causes heavy metal contamination in the Sea water of Aparri, Cagayan with a mean value of 4.0; Heavy metal residue in garbage can be carried over by flash floods to bodies of water causing heavy metal contamination with a mean value of 3.60; Heavy metal residues of pesticides and fertilizers can be washed by flash floods into bodies of water with a mean value of 3.70; Dredging disturb sea sediments causing accumulation of heavy metals to bodies of water with a mean value of 3.70; Oil spill is a possible cause of heavy metal contamination to bodies of water with a mean value of 3.50). This means that implementors know and can explain very well that factors like dynamite fishing, open site dumping, dredging, residues from fertilizers, pesticides and garbage can contaminate bodies of waters. According to them, this high level of awareness arise from the recorded reports of several incidences that may facilitate distribution of heavy metals to bodies of water especially in the sea water of Aparri, Cagayan.

Table 3.a. Level of awareness of respondents on heavy metal contamination in terms of causes

Statements	Fisher folk		Implementor		Both	
	MEAN	D.V.	MEAN	D.V.	MEAN	D.V.
Recreational activities like swimming contribute to heavy metal contamination of sea water	2.35	SA	3.10	MA	2.60	MA
Urbanization in Aparri facilitates heavy metal contamination of sea water	1.60	NA	2.20	SA	1.80	SA
Human activities like fishing contribute to heavy metal contamination of sea water	2.60	MA	3.40	HA	2.87	MA
Open site dumping near the bodies of waters in Aparri causes heavy metal contamination in the Sea water of Aparri, Cagayan	3.40	HA	4.0	HA	3.60	HAe
Heavy metal residue in garbages can be carried over by flash floods to bodies of water causing heavy metal contamination	3.55	HA	3.60	HA	3.57	HA

Heavy metal residues of pesticides and fertilizers can be washed by flash floods into bodies of water	3.50	HA	3.70	HA	3.57	HA
Dynamite fishing introduces toxic substance such as heavy metals in the bodies of water	2.80	MA	3.20	MA	2.93	MA
Dredging disturb sea sediments causing accumulation of heavy metals to bodies of water	2.55	MA	3.70	HA	2.93	MA
Oil spill is a possible cause of heavy metal contamination to bodies of water	2.35	SA	3.50	HA	2.73	MA
CATEGORICAL MEAN	2.74	MA	3.38	HA	2.96	MA

*NA- Not Aware at All; SA- Slightly Aware; MA-Moderately Aware; HA-Highly Aware

Table 3.b. presents the level of awareness of respondents on the effects of heavy metal contamination on bodies of water. The categorical mean is 2.93 with a descriptive value of moderately aware. This implies that, generally, even if stakeholders know the possible effects of heavy metal contamination to bodies of water, they still find difficulties in discussing or explaining it. This happens because even if implementors have high level of awareness, fisher folks tend to have moderate level of awareness considering that they only have limited sources of information about possible effects of heavy metal contamination to bodies of water. As per to what transcribed during the data collection, fisher folks are just relying on the information and educational programs they get over the radio and television which enables them to be aware towards heavy metal contamination on bodies of water particularly the sea water of Aparri, Cagayan. Implementors, on the other hand, have high level of awareness towards the effects of heavy metal contamination on bodies of water since they come to learn and gain it thru the studies they attained.

The combined level of awareness of respondents when it comes to statement (Heavy metals in seawater can be deposited to aquatic commodities which when ingested by man can cause diseases) is low. It has a mean of 2.27 with a descriptive value of slightly aware. This means that, generally, stakeholders are not really well knowledgeable that heavy metals can be accumulated to aquatic commodities causing harm to consumers. When it comes to statement parameter (When a person gets in contact with heavy metal found in water resources during activities like swimming and fishing, he/she can get skin diseases), stakeholders are moderately aware with a mean value of 2.90. This means that despite knowing that exposure to heavy metal contaminated bodies of water can cause skin diseases, they cannot fully explain or discuss how it can happen. Respondents were noted to have high level of awareness when it comes to statement (The higher is the accumulated heavy metal in the human body, the more severe disease can become) which has a mean of 3.63 with a descriptive value highly aware. This means that respondents can describe that disease is more severe when there is higher level of heavy metals accumulated in the human body.

In terms of the fisher folks, it can be deduced from the table below that they are not knowledgeable when it comes to statement (Heavy metals in seawater can be deposited to aquatic commodities which when ingested by man can cause diseases). It has a mean of 1.70 and a descriptive value of not aware at all. This poor level of awareness emanates from the fact that fisher folks do not have enough source of information about heavy metal contamination and intoxication. However, when it comes to statement (The higher is the accumulated heavy metal in the human body, the more severe disease can become), fisher folks have level of awareness described as highly aware with a mean of 3.75. This means that fisher folks are aware that the higher is the heavy metals accumulated in the human body, the more severe a disease can become.

When it comes to the implementors, they have high level of awareness on the effects of heavy metal contamination to bodies of water as per to statement (Heavy metals in seawater can be deposited to aquatic commodities which when ingested by man can cause diseases) with a mean of 3.40; When a person gets in contact with heavy metal found in water resources during activities like swimming and fishing, he/she can get skin diseases with a mean of 3.30; and The higher is the accumulated heavy metal in the human body, the more severe disease can become with a mean of 3.40). This means that implementors can discuss very well the possible consequences when one has been exposed to bodies of water or eaten aquatic commodities contaminated with heavy metal.

Table 3.b. Level of awareness of respondents on heavy metal contamination in terms of effects

Statements	Fisher folk		Implementor		Both	
	MEAN	D.V.	MEAN	D.V.	MEAN	D.V.
Heavy metals in seawater can be deposited to aquatic commodities which when ingested by man can cause diseases	1.70	NA	3.40	HA	2.27	SA
When a person gets in contact with heavy metal found in water resources during activities like swimming and fishing, he/she can get skin diseases	2.70	MA	3.30	HA	2.90	MA
The higher is the accumulated heavy metal in the human body, the more severe disease can become	3.75	HA	3.40	HA	3.63	HA
CATEGORICAL MEAN	2.72	MA	3.37	HA	2.93	MA

*NA- Not Aware at All; SA- Slightly Aware; MA-Moderately Aware; HA-Highly Aware

As presented in Table 3.c, respondents have a moderate level of awareness towards remediation on heavy metal contamination in bodies of water with a categorical mean of 2.71. Generally, this means that even if respondents are wary about the possible remediation on bodies of water known to be contaminated with heavy metals, they cannot fully explain or discuss it. This is because while implementors have high level of awareness in most of the possible remedial actions that can be done to mitigate heavy metal contamination to bodies of water, the level of awareness of fisher folks was recorded to be low with a descriptive value of slightly aware.

In terms of the fisher folks, they have low level of awareness when it comes to statement parameters (The prohibition of dynamite fishing mitigates heavy metal contamination of sea water with a mean of 2.40; The stoppage of dredging reduces heavy metal contamination of sea water with a mean of 2.15; Regular maintenance of motor boats and ships may reduce the possibilities of oil spill with a mean of 2.25; Microorganisms can be used to reduce heavy metal contamination in sea water with a mean of 2.45; Phytoremediation can be done to neutralize heavy metals with a mean of 2.25; Addition of adsorbent from organic sources help reduce heavy metal contamination in bodies of water with a mean of 1.95) which have a descriptive value of slightly aware. This low level of awareness among fisher folks emanates from the lack of experience and limited sources of information they get about remediation in treating contaminated sea water.

Fisher folks also mentioned that they never had a chance to participate in remediating activities in neutralizing heavy metals in sea water since it was not really measured in the sea of Aparri in the past five years. However, when it comes to statement (Proper waste management along sea shores may minimize heavy metal contamination of sea water), fisher folks have high level of awareness with a mean of 3.45 and descriptive value of highly aware. As accounted by the fisher folks, they were able to have this high level of awareness considering that the Department of Environment and Natural Resources held a community based education campaign about waste management upon the start of the rehabilitation projects on sea shores and riverbanks in 2019.

In terms of the implementors, they have a level of awareness described as moderately aware when it comes to statements (The stoppage of dredging reduces heavy metal contamination of sea water with a mean of 3.0 and Regular maintenance of motor boats and ships may reduce the possibilities of oil spill with a mean of 3.20) because they were less wary that heavy metals can be deposited on river bed and can be distributed on bodies of water once it is disturbed during dredging. When it comes to statement parameters (Proper waste management along sea shores may minimize heavy metal contamination of sea water with a mean of 3.50; The prohibition of dynamite fishing mitigates heavy metal contamination of sea water with a mean of 3.30; Microorganisms can be used to reduce heavy metal contamination in sea water with a mean of 3.40; Phytoremediation can be done to neutralize heavy metals with a mean of 3.30 and Addition of adsorbent from organic sources help reduce heavy metal contamination in bodies of water with a mean of 3.30), the descriptive value is highly aware.

This means that implementors are knowledgeable and can describe or discuss very well the remediation that can be done to polluted bodies of water. As described by these personnel, they come to have high level of awareness about these methods of remediating contamination to bodies of water considering that implementing agencies- Bureau of Fisheries and Aquatic Resources and Department of Environment and Natural Resources- have been trained when it comes to environmental pollution remediation and are currently re-intensifying their

programs toward water pollutions considering the most recent reports of anthropogenic activities (mining) that facilitates water pollutions in different water resources in the country in the past years.

Table 3.c. Level of awareness of respondents on heavy metal contamination in terms of remediation

Statements	Fisher folk		Implementor		Both	
	MEAN	D.V.	MEAN	D.V.	MEAN	D.V.
Proper waste management along sea shores may minimize heavy metal contamination of sea water	3.45	HA	3.50	HA	3.47	HA
The prohibition of dynamite fishing mitigates heavy metal contamination of sea water	2.40	SA	3.30	HA	2.70	MA
The stoppage of dredging reduces heavy metal contamination of sea water	2.15	SA	3.0	MA	2.43	SA
Regular maintenance of motor boats and ships may reduce the possibilities of oil spill	2.25	SA	3.20	MA	2.57	MA
Microorganisms can be used to reduce heavy metal contamination in sea water	2.45	SA	3.40	HA	2.77	MA
Phytoremediation can be done to neutralize heavy metals	2.25	SA	3.30	HA	2.60	MA
Addition of adsorbent from organic sources help reduce heavy metal contamination in bodes of water	1.95	SA	3.30	HA	2.40	SA
CATEGORICAL MEAN	2.41	SA	3.29	HA	2.71	MA

*NA- Not Aware at All; SA- Slightly Aware; MA-Moderately Aware; HA-Highly Aware

Table 3.d. shows that level of awareness of respondents when it comes to heavy metals contamination on sea water of Aparri, Cagayan has a descriptive value of moderately aware with a weighted mean of 2.87. The parameters towards heavy metal contamination namely causes (with a categorical mean of 2.96), effects (with a categorical mean of 2.93) and remediation on heavy metal contaminated sea water (with a categorical mean of 2.71) have a descriptive value of moderately aware. This implies that generally, respondents are aware and can discuss heavy metal contamination of sea water of Aparri, Cagayan

Table 3.d. Weighted Mean on the Level of Awareness of Stakeholders on Heavy Metal Contamination of Seawater of Aparri, Cagayan

Heavy Metal Contamination	Mean	D.V.
Causes of Heavy Metal Contamination of Sea Water	2.96	MA
Effects of Heavy Metal Contamination of Sea Water	2.93	MA
Remediations towards Heavy Metal Contamination of Sea Water	2.71	MA
Weighted Mean	2.87	MA

*NA- Not Aware at All; SA- Slightly Aware; MA-Moderately Aware; HA-Highly Aware

Level of Awareness of Stakeholders on Heavy Metal Intoxication

Table 4.a describes the level of awareness of stakeholders towards the pathophysiology of heavy metal intoxication. The categorical mean is 2.71 with a descriptive value of moderately aware. This means that generally, the respondents are aware of the pathophysiology of heavy metal intoxication but they could not explain it very well. Moreover, it can be also seen that both fisher folks and implementors have a moderate level of awareness towards the pathophysiology of heavy metal intoxication with a categorical mean of 2.56 and 3.0 respectively.

The combined level of awareness for both fisher folks and implementors is slightly aware in terms of the statement parameters in the mode of acquisition of heavy metal intoxication (Heavy metal intoxication may occur through ingestion of contaminated aquatic commodities with a mean of 2.47; Man accumulates heavy metals thru dermal contact to contaminated sea water with a mean of 2.47; Heavy metals can be acquired thru

inhalation of aerosol from contaminated sea water with a mean of 2.37), duration of exposure to heavy metal (The longer the exposure of man to sea water contaminated with heavy metal, the more severe the disease can become with a mean of 2.47) and concentration of heavy metal (When present in small amount, some heavy metals are essential to maintain the metabolism of the human body with a mean of 2.47). This means that the respondents are aware of the pathophysiology of heavy metal intoxication but they could not explain at all that different factors like manner of acquisition, duration of exposure to heavy metals and concentration of heavy metals that accumulated to human body can aggravate heavy metal intoxication. Moreover, it can be also seen that respondents have combined high level of awareness on statement parameters concerning the sources of heavy metal intoxication (Heavy metal intoxication in man comes from oil spillage in bodies of water with a mean of 3.70 and Heavy metal intoxication comes from human exposure to heavy metal polluted bodies of water with a mean of 3.77). This means that both respondents are aware of the source of heavy metal intoxication and can explain it very well.

In terms of the fisher folks, they have low level of awareness on the statement parameters on complications of heavy metal intoxication (Heavy metals can accumulate to human body over an extended period of time with a mean of 2.25; Heavy metal intoxication can lead to multiple organ problems with a mean of 2.35), mode of acquisition of heavy metal intoxication (Heavy metal intoxication may occur through ingestion of contaminated aquatic commodities with a mean of 2.40; Man accumulates heavy metals thru dermal contact to contaminated sea water with a mean of 2.20; Heavy metals can be acquired thru inhalation of aerosol from contaminated sea water with a mean of 2.0), duration of exposure to heavy metal (The longer the exposure of man to sea water contaminated with heavy metal, the more severe the disease can become with a mean of 2.30; The amount of heavy metal in the human body increases as the time goes by with a mean of 2.40), concentration of heavy metal (When present in small amount, some heavy metals are essential to maintain the metabolism of the human body with a mean of 2.30; Heavy metals can cause intoxication to man when exceeds tolerable limit set by the World Health Organization with a mean of 2.45) with a descriptive value of slightly aware. This means that fisher folks are aware of the pathophysiology of heavy metal intoxication but they cannot explain at all that factors like complications of heavy metal intoxication, mode of acquisition of heavy metal intoxication, duration of exposure to heavy metals and concentration of heavy metals are factors that aggravate heavy metal intoxication.

The level of awareness of fisher folks on statement parameters concerning the sources of heavy metal intoxication (Heavy metal intoxication in man comes from oil spillage in bodies of water with a mean of 3.75 and Heavy metal intoxication comes from human exposure to heavy metal polluted bodies of water with a mean of 3.75) has a descriptive value of highly aware. This means that fisher folks are aware and can explain very well the possible sources of heavy metal intoxication since they get their knowledge over the health programs they listen at over the radios and televisions

In terms of the implementors, their level of awareness on statement parameters on complications of heavy metal intoxication (Heavy metals can accumulate to human body over an extended period of time with a mean of 3.0; Heavy metal intoxication can lead to multiple organ problems with a mean of 2.80), mode of acquisition of heavy metal intoxication (Heavy metal intoxication may occur through ingestion of contaminated aquatic commodities with a mean of 2.60; Man accumulates heavy metals thru dermal contact to contaminated sea water with a mean of 3.00; Heavy metals can be acquired thru inhalation of aerosol from contaminated sea water with a mean of 3.10), duration of exposure to heavy metal (The longer the exposure of man to sea water contaminated with heavy metal, the more severe the disease can become with a mean of 2.80; The amount of heavy metal in the human body increases as the time goes by with a mean of 2.80), concentration of heavy metal (When present in small amount, some heavy metals are essential to maintain the metabolism of the human body with a mean of 2.80; Heavy metals can cause intoxication to man when exceeds tolerable limit set by the World Health Organization with a mean of 2.70) has a descriptive value of moderately aware. This means that implementors are aware of the pathophysiology of heavy metal intoxication and they can slightly explain that factors like complications of heavy metal intoxication, mode of acquisition of heavy metal intoxication, duration of exposure to heavy metals and concentration of heavy metals are factors that aggravate heavy metal intoxication. Furthermore, when it comes to statement parameters concerning the sources of heavy metal intoxication (Heavy metal intoxication in man comes from oil spillage in bodies of water with a mean of 3.60 and Heavy metal intoxication comes from human exposure to heavy metal polluted bodies of water with a mean of 3.80), the level of awareness the implementors had a descriptive value of highly aware. This means that they are aware and can explain very well the possible sources of heavy metal intoxication.

Table 4.a. Level of awareness of respondents on heavy metal intoxication in terms of pathophysiology

Statements	Fisherfolk		Implementor		Both	
	MEAN	D.V.	MEAN	D.V.	MEAN	D.V.
Source						
Heavy metal intoxication in man comes from oil spillage in bodies of water	3.75	HA	3.60	HA	3.70	HA
Heavy metal intoxication comes from human exposure to heavy metal polluted bodies of water	3.75	HA	3.8	HA	3.77	HA
Complications						
Heavy metals can accumulate to human body over an extended period of time	2.25	SA	3.0	MA	2.50	MA
Heavy metal intoxication can lead to multiple organ problems (renal diseases, blood diseases etc)	2.35	SA	2.80	MA	2.50	MA
Mode of Acquisition						
Heavy metal intoxication may occur through ingestion of contaminated aquatic commodities	2.40	SA	2.60	MA	2.47	SA
Man accumulates heavy metals thru dermal contact to contaminated sea water	2.20	SA	3.0	MA	2.47	SA
Heavy metals can be acquired thru inhalation of aerosol from contaminated sea water	2.0	SA	3.10	MA	2.37	SA
Duration						
The longer the exposure of man to sea water contaminated with heavy metal, the more severe the disease can become	2.30	SA	2.80	MA	2.47	SA
The amount of heavy metal in the human body increases as the time goes by.	2.40	SA	2.80	MA	2.53	MA
Concentration						
When present in small amount, some heavy metals are essential to maintain the metabolism of the human body.	2.30	SA	2.80	MA	2.47	SA
Heavy metals can cause intoxication to man when exceeds tolerable limit set by WHO	2.45	SA	2.70	MA	2.53	MA
CATEGORICAL MEAN	2.56	MA	3.0	MA	2.71	MA

*NA- Not Aware at All; SA- Slightly Aware; MA-Moderately Aware; HA-Highly Aware

Table 4.b reveals the level of awareness of respondents towards the signs and symptoms of heavy metal intoxication. The categorical mean is 2.40 with a descriptive value of slightly aware. In general, this means that respondents are aware of the signs and symptoms of heavy metal intoxication but they could not discuss or explain it at all. It can be also seen that while implementors are moderately aware of the signs and symptoms of heavy metal intoxication, fisher folks are slightly aware only

Respondents have poor level of awareness on the signs and symptoms of heavy metal intoxication as per to statement parameter (Headache with a mean value of 2.47, Liver Failure with a mean value of 2.40, Renal Damage with a mean value of 2.37; Respiratory Problems with a mean value of 2.47; Neurological Problem with a mean value of 2.37; Skin Disorder with a mean value of 2.47; Cancer Development with a mean value of 2.10 and Abnormal Fetal Development with a mean value of 2.27) with a descriptive value of slightly aware. This means that respondents are aware that headache, liver failure, renal damage, respiratory problems, neurological problem, skin disorder, cancer development and abnormal fetal development are signs and symptoms of heavy metal intoxication but they could not discuss or explain it at all. However, on statement parameter (Multiple Organ Disorder with a mean value of 2.57 and blood disorders with a mean value of 2.50),

the level of awareness of respondents has a descriptive value of moderately aware. This means that respondents are aware and can discuss partially that multiple organ disorders and blood disorders are signs and symptoms of heavy metal intoxication.

When it comes to the fisher folks, their level of awareness on signs and symptoms of heavy metal intoxication particularly to all statement parameters (Headache with a mean value of 2.40, Multiple Organ Disorder with a mean value of 2.45, Liver Failure with a mean value of 2.35, Renal Damage with a mean value of 2.30, Blood Disorder with a mean value of 2.45, Respiratory Problems with a mean value of 2.30; Neurological Problem with a mean value of 2.25; Skin Disorder with a mean value of 2.30; Cancer Development with a mean value of 1.90 and Abnormal Fetal Development with a mean value of 1.95) has a descriptive value of slightly aware. This means that fisher folks are aware that headache, multiple organ disorder, liver failure, renal damage, respiratory problems, blood disorder, neurological problem, skin disorder, cancer development and abnormal fetal development are signs and symptoms of heavy metal intoxication but they could not discuss or explain it at all since they are just relying on what they hear on health programs over the radios and televisions making their knowledge about signs and symptoms of heavy metal intoxication to be limited.

As per to the implementors, their level of awareness on signs and symptoms of heavy metal intoxication particularly to all statement parameters (Headache with a mean value of 2.60, Multiple Organ Disorder with a mean value of 2.80, Liver Failure with a mean value of 2.50, Renal Damage with a mean value of 2.50, Blood Disorder with a mean value of 2.60, Respiratory Problems with a mean value of 2.80; Neurological Problem with a mean value of 2.60; Skin Disorder with a mean value of 2.80; Cancer Development with a mean value of 2.50 and Abnormal Fetal Development with a mean value of 2.90) has a descriptive value of moderately aware. This means that implementors are aware and can discuss partially that headache, multiple organ disorder, liver failure, renal damage, respiratory problems, blood disorder, neurological problem, skin disorder, cancer development and abnormal fetal development are signs and symptoms of heavy metal intoxication. Implementors account their knowledge about signs and symptoms of heavy metal intoxication on what they learned in their studies and to that of what they read about heavy metals.

Table 4.b. Level of awareness of respondents on heavy metal intoxication in terms of signs and symptoms

Statements	Fisher folk		Implementor		Both	
	MEAN	D.V.	MEAN	D.V.	MEAN	D.V.
Headache	2.40	SA	2.60	MA	2.47	SA
Multiple Organ Disorders	2.45	SA	2.80	MA	2.57	MA
Liver Failure	2.35	SA	2.50	MA	2.40	SA
Renal Damage	2.30	SA	2.50	MA	2.37	SA
Blood Disorders (Leukemia/Hemolytic Disorders)	2.45	SA	2.60	MA	2.50	MA
Respiratory Problems (Asthma)	2.30	SA	2.80	MA	2.47	SA
Neurological Problems (Loss Of Memory And Dullness)	2.25	SA	2.60	MA	2.37	SA
Skin Disorders	2.30	SA	2.80	MA	2.47	SA
Cancer Development	1.90	SA	2.50	MA	2.10	SA
Abnormal Fetal Development	1.95	SA	2.90	MA	2.27	SA
CATEGORICAL MEAN	2.27	SA	2.66	MA	2.40	SA

*NA- Not Aware at All; SA- Slightly Aware; MA-Moderately Aware; HA-Highly Aware

Table 4.c shows the level of awareness of respondents towards the prevention and control on heavy metal intoxication. The categorical mean is 2.84 with a descriptive value of moderately aware. It implies that stakeholders are aware and can slightly discuss the prevention and control on heavy metal intoxication. It can be also seen that both fisher folks and implementors are moderately aware of the prevention and control on heavy metal intoxication

The table also shows that the level of awareness of respondents on statement parameters (Wearing of face mask when going near water resources known to be contaminated with heavy metal can prevents possible

inhalation of heavy metals with a mean value of 2.40 and Less exposure or conduct of human activity to seawater contaminated with heavy metal is an easy means to prevent heavy metal intoxication with a mean value of 2.43) has a descriptive value of slightly aware. This means that though respondents are generally aware that wearing of face mask when going near water resources known to be contaminated with heavy metal and less exposure or conduct of human activity to seawater contaminated with heavy metal is an easy means to prevent heavy metal intoxication, they cannot discuss or explain it well. However, respondents have high level of awareness when it comes to statement parameters (Regular medical consultation reduces the complication of heavy metal intoxication with a mean value of 3.43 and Taking of medicines that can neutralize the effect of heavy metal in the body with a mean value of 3.67). This manifests that respondents are aware and can explain very well that regular medical consultation and medication mitigate the effect of heavy metal intoxication in the human body.

When it comes to the fisher folks, Table 4.3 reveals that their level of awareness in statement parameters (Reduction in consuming aquatic commodities taken from sea water contaminate with heavy metals minimize the risk of heavy metal intoxication with a mean value of 2.45; Less exposure or conduct of human activity to seawater contaminated with heavy metal is an easy means to prevent heavy metal intoxication with a mean value of 2.40; Periodic monitoring of heavy metal concentration in water resources with a mean value of 2.40 and Wearing of face mask when going near water resources known to be contaminated with heavy metal can prevents possible inhalation of heavy metals with a mean value of 2.35) is low with a descriptive value of slightly aware. This implies that fisher folks are aware yet they cannot discuss that reduction in the consumption of aquatic commodities taken from sea water contaminated with heavy metals, less exposure or conduct of human activity to seawater contaminated with heavy metal, periodic monitoring of heavy metal concentration in water resources and wearing of face mask when going near water resources known to be contaminated with heavy metal are preventive and control measures towards heavy metal intoxication. Nonetheless, fisher folks are highly aware that statement parameter regular medical consultation with a mean value of 3.50 can reduce the complication of heavy metal intoxication

As for the implementors, it can be deduced from the table that their level of awareness on statement parameters (Reduction in consuming aquatic commodities taken from sea water contaminated with heavy metals minimize the risk of heavy metal contamination with a mean value of 2.60; Less exposure or conduct of human activity to seawater contaminated with heavy metal is an easy means to prevent heavy metal intoxication with a mean value of 2.50; Periodic monitoring of heavy metal concentration in water resources with a mean value of 3.0; Wearing of face mask when going near water resources known to be contaminated with heavy metal can prevents possible inhalation of heavy metals with a mean value of 2.5) is low with a descriptive value of moderately aware. This means that even if implementors know that reduction in human consumption of aquatic commodities taken from sea water contaminate with heavy metals, less exposure or conduct of human activity to seawater contaminated with heavy metals, periodic monitoring of heavy metal concentration in water resources, wearing of face mask when going near water resources known to be contaminated with heavy metal prevent possible heavy metal intoxication, they can still hardly explain or discuss it. However, implementors have high level of awareness when it comes to statement parameters (Regular medical consultation reduces the complication of heavy metal intoxication with a mean value of 3.30 and Taking of medicines that can neutralize the effect of heavy metal in the body with a mean vaue of 3.70). This means that they can explain very well that regular medical consultation and medication helps to mitigate the effect of heavy metal intoxication in the human body.

Table 4.c. Level of awareness of respondents on heavy metal intoxication in terms of prevention and control

Statements	Fisherfolk		Implementor		Both	
	MEAN	D.V.	MEAN	D.V.	MEAN	D.V.
Reduction in consuming aquatic commodities taken from sea water contaminate with heavy metals minimize the risk of heavy metal contamination	2.45	SA	2.6	MA	2.50	MA
Less exposure or conduct of human activity to seawater contaminated with heavy metal is an easy means to prevent heavy metal intoxication	2.40	SA	2.50	MA	2.43	SA
Regular medical consultation reduces the complication of heavy metal intoxication	3.50	HA	3.30	HA	3.43	HA

Periodic monitoring of heavy metal concentration in water resources	2.40	SA	3.0	MA	2.60	MA
Wearing of face mask when going near water resources known to be contaminated with heavy metal can prevents possible inhalation of heavy metals	2.35	SA	2.50	MA	2.40	SA
Taking of medicines that can neutralize the effect of heavy metal in the body.	2.65	MA	3.70	HA	3.67	HA
CATEGORICAL MEAN	2.79	MA	2.93	MA	2.84	MA

*NA- Not Aware at All; SA- Slightly Aware; MA-Moderately Aware; HA-Highly Aware

Table 4.d. presents that the weighted mean on the level of awareness of respondents on heavy metal intoxication is 2.65 with a descriptive value of moderately aware. This means that though they are aware about heavy metal intoxication, they can hardly explain or discuss its pathophysiology, signs and symptoms and prevention and control.

The table also reveals that respondents have low level of awareness on the signs and symptoms of heavy metal intoxication with a categorical mean of 2.40 with a descriptive value of slightly aware. This implies that respondents are wary with the signs and symptoms of diseases yet cannot discuss it well when it comes to heavy metal intoxication. Fernandes (2008) described that individuals have low level of awareness when it comes to the manifestations of heavy metal intoxication considering that some heavy metals are essential in the human body. This means that people are less cognizant when it comes to heavy metal intoxication because most manifestations related to it are seen also in other diseases making people rule out heavy metal intoxication as the cause of a disease. The respondents were also observed to have a moderate level of awareness when it comes to pathophysiology and prevention and control measures for Heavy Metal Intoxication as described by its categorical mean of 2.71 and 2.84 respectively. This means that even if respondents are aware about the pathophysiology and preventive and control measures for heavy metal intoxication, they can still hardly discuss it well.

Table 4.d. Weighted mean on the level of awareness of respondents on heavy metal intoxication

Heavy Metal Intoxication	Cat. Mean	D.V.
Pathophysiology of Heavy Metal Intoxication	2.71	MA
Signs and Symptoms of Heavy Metal Intoxication	2.40	SA
Prevention and Control of Heavy Metal Intoxication	2.84	MA
Weighted Mean	2.65	MA

*NA- Not Aware at All; SA- Slightly Aware; MA-Moderately Aware; HA-Highly Aware

Table 5.1.a. reveals that at 5% level of significance, there is a sufficient evidence to say that there is a significant difference on the level of awareness of respondents on heavy metal contamination in terms of causes when grouped according to number of seminars attended on heavy metal contamination, frequency of immersion to sea water, educational attainment, average net monthly income, position and length of service.

In terms of number of seminars attended, bedural (2011) described that the number of seminars attended by respondents is directly proportional when it comes to their level of awareness on environmental issues. This implies that as the number of seminars attended by respondents towards heavy metal contamination increases, the more aware they become about its causes. The table also shows that the more frequent respondents get immersed in bodies of water, the more aware they become when it comes to the causes of heavy metal contamination. This is attributed to the experience and observation they get every time they are in bodies of water. The fisherfolks attested that there are probable events, such as improper waste disposal along the sea shores, that facilitate contamination of sea water.

When it comes to educational attainment, Bedural (2018) describes that people with high educational attainment are more cognizant when it comes to causes of environmental concerns. This only means that the higher the educational attainment the respondents get, the more aware they are when it comes to the causes of heavy metal contamination to bodies of water because of the learnings they gain in their studies. In terms of average net monthly income, there is a significant difference on the level of awareness of respondents towards causes of heavy metal contamination considering that people with higher net monthly income have the

economic advantage to get better level of environmental awareness since they are capable to have multiple sources of information about environmental issues (Angeoletto et al., 2017). Furthermore, respondents that have higher positions and are in service for a longer period of time are more aware when it comes to causes of heavy metal contamination because they gain more experiences, trainings and information as they stay longer in their positions.

Table 5.1.a. Significant Difference on the Level of Awareness of Respondents on Heavy Metal Contamination in terms of Causes when Grouped According to Profile Variables

Profile Variables	Chi-Square	df	Asymp.Sig.
Age	7.832	6	0.251
Marital Status	0.100	1	0.752
Number of Seminars Attended on Heavy Metal Contamination and Intoxication	6.265	2	0.044*
Frequency of Immersion to Sea Water	9.159	3	0.027*
Educational Attainment	15.344	6	0.018*
Average Net Monthly Income	11.461	4	0.022*
Position	6.270	2	0.043*
Length of Service	13.941	6	0.030*
Encumbered Appliances for Communication and Information	0.017	1	0.896
Current Ailment	1.102	2	0.576
Comorbidity	0.653	2	0.721

Table 5.1.b. shows that at 5% level of significance, there is a sufficient evidence to say that there is no significant difference on the level of awareness of the respondents on heavy metal contamination in terms of causes when grouped according to sex and membership in an organization. This implies that sex and membership of respondents to an organization do not affect their awareness about heavy metal contamination in terms of causes.

Table 5.1.b. Significant Difference on the Level of Awareness of Respondents on Heavy Metal Contamination in terms of Causes when Grouped According to Profile Variables (Mann-Whitney U Test)

Profile Variable	Mann-Whitney U Test	Wilcoxon W	Z	Asymp. Sig. (2 Tailed)	Exact. Sig. {2*1-Tailed Sig.}]
Sex	71.500	107.500	-1.109	0.267	0.447 ^b
Membership in Organizations	85.000	275.000	-1.203	0.229	0.420 ^b

Table 5.1.c. describes that at 5% level of significance, there is a sufficient evidence to say that there is a significant difference on the level of awareness of respondents towards heavy metal contamination in terms of effect when grouped according to age, number of seminars attended on heavy metal contamination, educational attainment, average net monthly income and encumbered appliances, while there is a sufficient evidence to say that there is a significant difference on the level of awareness of respondents towards heavy metal contamination in terms of remediation when grouped according to age, number of seminars attended, educational attainment, frequency of immersion to seawater, average net income, position, length of service, encumbered appliances.

In terms of age, Aminrad et al. (2011) described it to be directly proportional to environmental awareness. This is more likely because older respondents tend to have more experiences, observations, trainings and education through Information and Education Campaign materials making them more aware towards the effects of heavy metal contamination. In terms of number of seminars attended, bedural (2011) described that the number of seminars attended by respondents is directly proportional when it comes to their level of awareness on environmental issues. This implies that as the number of seminars attended by respondents towards heavy metal contamination increases, the more aware they become about its effects.

When it comes to educational attainment, Zimmerman and Woolf (2014) described that people who attained low level of education are more likely exposed to workplaces with more environmental concerns in order to get economic advantages for living. They tend to become less wary of possible effects of environmental issues such as that of air and water pollution to their health. This reconciles with the finding of Bedural (2018) wherein people with high educational attainment are more cognizant when it comes to environmental concerns and its effect to their well-being. This only means that the higher the educational attainment the respondent gets, the more aware they are when it comes to the effect of environments issues such that of heavy metal contamination to bodies of water.

In terms of net monthly income, it was observed that respondents with high monthly income have high level of awareness on the effect of heavy metal contamination. As described by Angeoletto et al.(2017), people with higher net monthly income have the economic advantage to get better level of environmental awareness since they are capable to have multiple sources of information about environmental issues. As per to the encumbered appliances, these have great impact in making the general public aware of the day to day events and issues in one place. Brother et al.(2010) described encumbered appliances such as television and radio as an effective medium to educate the public about the environment. This means that the more the encumbered appliances the respondents have, the more aware they become about the effects of heavy metal contamination.

The table also shows that the more frequent respondents get immersed in bodies of water, the more aware they become when it comes to remediation. This is attributed to the experience and observation they get every time they are in bodies of water. Respondents that have higher positions and are in service for a longer period of time are more aware when it comes to remediations towards heavy metal contamination because they gain more experiences, trainings and information as they stay longer in their positions.

Table 5.1.c. Significant Difference on the Level of Awareness of Respondents on Heavy Metal Contamination in terms of Effects and Remediations when Grouped According to Profile Variables

		Effects				Remediations			
		Sum of Squares	df	F	Sig.	Sum of Squares	df	F	Sig.
Age	Between Groups	3.567	6	2.645	0.042	3.274	6	2.541	0.0498
	Within Groups	5.169	23			4.939	23		
	Total	8.737	29			8.213	29		
Marital Status	Between Groups	0.402	1	1.351	0.255	0.597	1	2.194	0.15
	Within Groups	8.335	28			7.616	28		
	Total	8.737	29			8.213	29		
Number of Seminars Attended on Heavy Metal Contamination and	Between Groups	3.936	3	7.103	0.002	5.113	3	14.287	0*
	Within Groups	4.803	26			3.102	26		
	Total	8.738	29			8.214	29		

Intoxication									
Frequency of Immersion to seawater	Between Groups	2.357	6	1.416	0.251	5.254	6	6.808	0*
	Within Groups	6.38	23			2.958	23		
	Total	8.737	29			8.213	29		
Educational Attainment	Between Groups	3.935	3	7.102	0.001	5.112	3	14.286	0*
	Within Groups	4.802	26			3.101	26		
	Total	8.737	29			8.213	29		
Average Net income	Between Groups	2.753	4	2.875	0.044	4.3	4	6.87	0.001*
	Within Groups	5.984	25			3.912	25		
	Total	8.737	29			8.213	29		
Position	Between Groups	2.453	6	1.498	0.227	4.325	6	4.263	0.006*
	Within Groups	6.286	23			3.890	23		
	Total	8.737	29			8.214	29		
Length of Service	Between Groups	2.452	6	1.496	0.224	4.323	6	4.261	0.005*
	Within Groups	6.284	23			3.889	23		
	Total	8.737	29			8.213	29		
Encumbered Appliances for communication and Information	Between Groups	1.484	1	5.728	0.024	1.778	1	7.737	0.01*
	Within Groups	7.253	28			6.435	28		
	Total	8.737	29			8.213	29		
Current Ailment	Between Groups	0.083	2	0.129	0.879	0.451	2	0.784	0.467
	Within Groups	8.654	27			7.762	27		
	Total	8.737	29			8.213	29		
Comorbidity	Between Groups	0.089	2	0.130	0.880	0.452	2	0.785	0.469
	Within Groups	8.656	27			7.763	27		
	Total	8.738	29			8.214	29		

Table 5.1.d. describes that at 5% level of significance, there is a sufficient evidence to say that there is no significant difference on the level of awareness of stakeholders towards the effects of and remediation towards heavy metal contamination when grouped according to Sex and Membership to Organization. This

implies that sex and membership to organization have no significant impact on the awareness of respondents towards the effects of and remediation towards heavy metal contamination.

Table 5.1.d. Significant Difference on the Level of Awareness of Respondents on Heavy Metal Contamination in terms of Effects and Remediations when Grouped According to Sex and Membership to Organization

INDEPENDENT SAMPLES TEST									
		EFFECT				REMEDICATION			
		Levene's Test	t-test for Equality of Means			Levene's Test	t-test for Equality of Means		
		F	t	df	Sig. (2-tailed)	F	t	df	Sig. (2-tailed)
Sex	Equal variances assumed	0.267	-0.15	28	0.886	1.23	-1.92	28	0.065
	Equal variances not assumed		-0.13	10.9	0.896		-1.68	10.1	0.123
Membership to Organization	Equal variances assumed	0.013	0.18	28	0.860	0.684	0.73	28	0.47
	Equal variances not assumed		0.18	21.99	0.858		0.71	18.7	0.489

Table 5.2.a. reveals that at 5% level of significance, there is a sufficient evidence to say that there is a significant difference on the level of awareness of respondents towards heavy metal intoxication in terms of pathophysiology when grouped according to frequency of immersion to sea water, average net monthly income, length of service and encumbered appliances.

It can be deduced from the table that the more frequent respondents get immersed in bodies of water, the more aware they become when it comes to heavy metal intoxication in terms of pathophysiology. This is supported by the findings of Ismaniza and Saleh (2012) wherein individuals who get exposed to bodies of waters experience and observe possible sources of ailments related to pollutions in the environment. In terms of average net monthly income, it was observed that respondents with high monthly income have high level of awareness towards heavy metal intoxication in terms of pathophysiology. As described by Angeoletto et al.(2017), people with higher net monthly income have the economic advantage to get better level of environmental awareness and its impact since they are capable to have multiple sources of information.

Respondents that are in service for a longer period of time are more knowledgeable when it comes to heavy metal intoxication in terms of pathophysiology because they gain more experiences, trainings and information as they stay longer in service. As per to the encumbered appliances, Brother et al.(2010) described encumbered appliances such as television and radio as an effective medium to educate the public about environmental issues and its impact to one's health. Encumbered appliances adds up to the awareness of people towards societal issues which may include environmental concerns and its impact to public health. This means that the more the encumbered appliances the respondents have, the more aware they become about heavy metal contamination in terms of remediation.

Table 5.2.a. Significant Difference on the Level of Awareness of Respondents on Heavy Metal Intoxication in terms of Pathophysiology, Signs and Symptoms and Prevention and Control when Grouped According to Profile Variables

Profile Variables	Pathophysiology of Heavy Metal Intoxication			Signs and Symptoms of Heavy Metal Intoxication			Prevention and Control on Heavy Metal Intoxication		
	Chi Square	df	Asymp. Sig.	Chi Square	df	Asymp. Sig.	Chi Square	df	Asymp. Sig.
Age	3.451	6	0.750	7.044	6	0.317	2.918	6	0.819
Marital Status	0.061	1	0.804	0.119	1	0.730	0.031	1	0.860
Number of Seminars Attended	1.866	2	0.393	1.131	2	0.568	0.636	2	0.727
Frequency of Immersion	15.602	3	0.001*	7.170	3	0.067	4.080	3	0.253
Educational Attainment	9.476	6	0.149	5.288	6	0.507	4.526	6	0.606
Average Net Monthly Income	9.998	4	0.040*	2.440	4	0.655	1.150	4	0.886
Length of Service	14.322	6	0.026*	7.506	6	0.277	3.065	6	0.801
Encumbered Appliances	5.789	1	0.016*	1.659	1	0.198	0.165	1	0.684
Current Ailment	0.354	2	0.838	1.921	2	0.383	1.856	2	0.395
Comorbidity	4.639	2	0.098	2.422	2	0.298	1.647	2	0.439

Table 5.2.b.1. shows that at 5% level of significance, there is sufficient evidence to say that there is no significant difference on the level of awareness of respondents in terms of heavy metal intoxication in terms of pathophysiology when grouped according to sex and membership on an organization. This means that sex and membership on an organization do not affect the awareness of stakeholders towards the pathophysiology of heavy metal intoxication.

Table 5.2.b.1. Significant Difference on the Level of Awareness of the Respondents on Heavy Metal Intoxication in terms of Pathophysiology when Grouped According to Profile Variable

	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig (2-Tailed)	Exact Sig. {2*1-Tailed Sig.}]
Sex	80.0	333.0	-0.379	0.704	0.730 ^b
Membership on an organization	94.0	284.0	-0.457	0.648	0.672 ^b

Table 5.2.b.2. shows that at 5% level of significance, there is sufficient evidence to say that there is no significant difference on the level of awareness of respondents in terms of heavy metal intoxication in terms of signs and symptoms when grouped according to sex and membership on an organization. This means that sex and membership on an organization do not affect the awareness of stakeholders towards the signs and symptoms of heavy metal intoxication.

Table 5.2.b.2. Significant Difference on the Level of Awareness of Respondents on Heavy Metal Intoxication in terms of Signs and Symptoms when Grouped According to Profile

	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig (2-Tailed)	Exact. Sig. {2*1-Tailed Sig.}]
Sex	82.0	335.0	-0.283	-0.777	0.801 ^b
Membership on an organization	81.0	271.0	-1.017	0.309	0.328 ^b

Table 5.2.b.3 shows that at 5% level of significance, there is sufficient evidence to say that there is no significant difference on the level of awareness of respondents in terms of heavy metal intoxication in terms of prevention and control when grouped according to sex and membership on an organization. This means that sex and membership on an organization do not affect the awareness of stakeholders towards the prevention and control of heavy metal intoxication.

Table 5.2.b.3. Significant Difference on the Level of Awareness of the Respondents on Heavy Metal Intoxication in terms of Prevention and Control when Grouped According to Profile

	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig (2-Tailed)	Exact. Sig. {2*1-Tailed Sig.}]
Sex	80.5	116.5	-0.360	0.719	0.730 ^b
Membership on an organization	89.0	155.0	-0.684	0.494	0.525 ^b

Summary of Findings

Considering the data collected in this study, the sea water of Aparri, Cagayan is contaminated with heavy metals particularly Arsenic that was measured to be higher than the threshold value regardless of tidal status and site of sample collection and Cadmium that was recorded to be above threshold value at the fishing area during low tides only.

It was also noted that respondents- fisher folks and implementors- have a moderate level of awareness when it comes to heavy metal contamination and intoxication. This implies that even if respondents are knowledgeable about heavy metal contamination and intoxication, they still find difficulties in discussing or describing it thoroughly. Considering this, a program plan towards heavy metal contamination and intoxication control program that covers intensive Information Education Campaign thru tri-media, Surveillance and Prevention and Control of Heavy Metal Contamination and Intoxication was proposed for the municipality of Aparri, Cagayan.

Conclusion

Considering the data collected, the researcher concludes that the sea water of Aparri is contaminated with Arsenic and Cadmium. Furthermore, the respondents- fisher folks and implementors- have a moderate level of awareness when it comes to heavy metal contamination and intoxication.

Recommendation

Based on the findings in this research, the researcher recommends that:

1. BFAR and DENR may consider including in their operation the surveillance and monitoring of heavy metals in bodies of water and aquatic commodities. They should also consider intensifying information and education campaign materials towards heavy metal contamination on bodies of water.

2. Local Government Unit of Aparri may implement a community based program plan towards heavy metal contamination and intoxication control program
3. The Department of Health may strengthen dissemination of Information Education Campaign materials about heavy metal intoxication.
4. Fisher folks, individuals frequently exposed to bodies of water known to be contaminated with heavy metals and consumers of aquatic commodities taken from bodies of water contaminated with heavy metals may undergo periodic medical consultation.
5. Future researchers may conduct studies on determinants of heavy metal contamination and heavy metal intoxication.

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