Health Risk Impact of Cadmium Exposure on Public Drinking Water Sources in Kodingareng and Barrang Lompo Islands Sangkarrang District Makassar City

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Abstract
The condition of water sources in coastal areas has decreased in quality caused by marine pollution. The source of marine pollution is marine debris. Marine debris is a persistent solid object, produced or processed by humans. Indifference and inability to overcome problems and waste management results in environmental quality degradation. Heavy metals are considered as one of the sources of pollution in well water which is used as a source of drinking water. Heavy metals in water and the environment expose humans to many health risks. This research is a research using environmental health risk analysis method. Environmental Health Risk Analysis is an analytical process carried out to calculate or predict health risks from contamination parameters with certain intake levels, intake rates and body weight. This study aims to determine the level of non-carcinogenic risk (RQ) and carcinogenic risk (ECR) of exposure to heavy metal cadmium (Cd) in well water used as a source of drinking water for people on Kodingareng Island and Barrang Lompo Island. This research is an observational research with an environmental health risk analysis design approach with 6 environmental samples and 68 human samples. Data were analyzed by ARKL method and using Microsoft Office Excel and SPSS programs. The results showed that the average concentration of heavy metal cadmium (Cd) in the respondents’ drinking water sources was < 0.0002 mg/L and was still below the permissible cadmium (Cd) concentration threshold based on Health Ministry Regulation no. 492 of 2010 for drinking water requirements. The level of non-carcinogenic risk from the consumption of drinking water containing heavy metal cadmium (Cd) indicates that the respondent has no risk or RQ 1 for an exposure duration of 5 – 30 years, while the level of carcinogenic risk indicates that the respondent has an unsafe risk level or ECR > 1/10,000 at an exposure duration of 30-70 years.

Key Words: EHRA, Exposure, Lifetime, Heavy Metals, Groundwaters.

Introduction
Domestic activities of coastal and island communities may have an effect on the quality and amount of groundwater available. Humans utilize water for a variety of purposes, the most essential of which is as clean water and raw water to be treated into drinking water. Groundwater is the primary source of water, which is critical for tiny islands that are isolated from the mainland. Groundwater must maintain a level of water quality consistent with the requirements of the human body (Ananda, 2017). Well water, which is the primary supply of safe drinking water for tiny island populations, has both quality and quantity limits. According to data from many studies conducted on tiny islands around Makassar City, it was discovered that the majority of the people relied on dug wells for potable water (Birawida, 2017).

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On small islands, waste disposal and collection occur continuously throughout the year. Every day, rubbish is transported by currents and waves. The island’s state, which precludes the development of a landfill, forces tiny residents to utilize the water as a garbage can. Marine debris is a permanent solid item that people create or process. Discharged or abandoned in the maritime environment is mainly a result of community domestic activities, with around 80% coming from land and 20% from ship operations, such as offshore oil refineries. Garbage on the coastlines and seas degrades the physical quality of the surrounding ecosystem, including the soil, water, rivers, coasts, and sea water. (National Oceanic and Atmospheric Administration, 2013).

The issue with trash management on Kodingareng and Barrang Lompo Islands is that locals discard rubbish in the sea by burning it or dumping it straight into it. Environmental quality is deteriorated as a consequence of indifference and incapacity to resolve issues and manage trash. Population growth results in an increase in trash creation. Inadequate garbage disposal facilities and lack of information about the management and effect of trash created. Waste that is not adequately handled, whether purposefully or inadvertently, may reach the seas (Citrarasi et al., 2012 in Birawida, 2017). Heavy metals are anthropogenic elements that must be monitored closely, since they may be dispersed temporally and geographically by garbage or items entering coastal waterways (Rangkuti et al., 2017).

According to the Central Bureau of Statistics (2021), more than half of houses in Indonesia, or 57.42 percent, directly discharge waste water from bathrooms, washing areas, and kitchens into sewers/sewers/rivers/sea. Additionally, 18.7 percent of households disposed of garbage directly into the ground, 10.26 percent into septic tanks, 18.71 percent into infiltration wells, and just 1.28 percent through wastewater treatment facilities (WWTP). Heavy metal pollution indicates that the majority of sources are anthropogenic, such as home trash disposal. Contamination of groundwater by anthropogenic waste is a significant issue in highly populated places (Nyambura et al., 2020). When groundwater extraction exceeds the recharge level in densely populated coastal regions, saltwater intrusion occurs (Mahesha and Lakshmikant, 2014). Seawater intrusion is often one of the concerns in coastal areas and is almost always associated with pollution problems. water can result in a deterioration in groundwater quality, such as water becoming salty due to elevated salt levels. Saltwater intrusion is a phenomena that occurs when seawater seeps into groundwater, either naturally or intentionally, as a result of groundwater being utilized for home purposes and other purposes (Malisan, 2011).

The presence of heavy metals in water and the environment poses several health concerns to people. Heavy metals are a known cause of contamination in drinking water sources (Chege et al., 2013). Numerous heavy metals are very hazardous due to the fact that their compounds are highly soluble in water (Ademola et al., 2015). Cadmium is a heavy metal that is not required by the human body and is even harmful on a tiny scale. Even at low quantities, metallic cadmium (Cd) is the most poisonous element. Chronic exposure to high levels of Cd may result in bone loss, cancer, diarrhea, hair loss, renal damage, dermatitis, reduced kidney function, itai-itai illness, and depression (Koki et al., 2015) However, research on heavy metals in groundwater, particularly in coastal areas of South Sulawesi, is limited. In the absence of research on the risk of heavy metals in groundwater to human health, the researchers are interested in researching and analyzing the risk associated with exposure to the heavy metal cadmium (Cd) in drinking water sources in the communities of Kodingareng Lompo Island and Barrang Lompo District Makassar City Cage.

The environmental health risk analysis approach is one way for determining the effect of heavy metal exposure on the drinking water drank. Environmental Health Danger Analysis is a quantitative method for calculating or determining the risk to specific species or communities from heavy metal exposure. By calculating the amount of intake, an intake rate, and a body weight, we may forecast when the influence of a pollutant parameter happens. Both non-carcinogenic and carcinogenic effects are possible.

**Methods**

This research was conducted on Kodingareng and Barrang Lompo Islands, Sangkarrang District, Makassar City, carried out in February - April 2022. The population in this study consisted of 2 types, namely the object and subject population. The object population (environment) is shallow groundwater, while the subject population (humans) are people who live on Kodingareng and
Barrang Lompo islands. Sampling is done by purpose sampling. Environmental samples were well water which was used as a source of drinking water for respondents, three samples on Kodingareng Island and three samples on Barrang Lompo Island. Human samples are people who consume shallow groundwater or well water as drinking water as many as 68 respondents. Water samples were taken at three different points, namely in the middle of the island and on the edge of the island or close to the shoreline on each island. Cadmium (Cd) analysis in raw water samples for drinking water was performed in the laboratory using an Atomic Absorption Spectrophotometer (AAS) in accordance with the Indonesian National Standard (SNI) method. The findings of a descriptive analysis of the content of the heavy metal Cd in drinking water sources are reported.

The permissible level of cadmium (Cd) in drinking water sources may be determined by comparing it to the drinking water quality requirements established in Minister of Health Regulation 492 of 2010. Cadmium levels in drinking water must meet a quality requirement of 3 x 10^-3 mg/L. This study used an observational survey design in conjunction with an Environmental Health Risk Analysis (ARKL) technique to quantify and forecast the incidence of a health impact associated with the presence of certain pollutant characteristics in the environment. Environmental health risk analysis is separated into five stages: hazard identification, dose-response analysis, exposure analysis, risk characterization, and risk mitigation handling of risks (Rahman, 2007). The following equation was used to evaluate exposure (Rahman, 2007).

The results of the calculation of Risk Quotients (RQ) can show the level of health risk due to consuming ground water or well water as a source of drinking water containing heavy metals. If the RQ 1 indicates the exposure is still below the normal limit and people who consume well water as a source of
drinking water are safe from health risks to the detergent residue throughout their lives. Meanwhile, if the RQ value > 1 indicates the exposure is above the normal limit and people who consume well water as a source of drinking water are at risk of experiencing health problems due to heavy metal cadmium (Cd) contamination, while the results of the Excess Cancer Risk (ECR) calculation the risk level is expressed in numbers exponent without units. The level of risk is said to be acceptable or safe if ECR ≤ 1/10,000 or expressed by ECR ≤ 1/10,000 The level of risk is said to be unacceptable or unsafe if the ECR > 1/10,000 or stated by the ECR > 1/10,000. The level of risk is said to be unacceptable or unsafe if the ECR > 1/10,000 or stated by ECR > 1/10,000.

Table 1 shows the number of respondents in this study as many as 68 respondents, namely 35 respondents on Kodingareng Lombo Island and 33 respondents on Barrang Lombo Island. Most of the respondents were male (57.3%) with the most age group being 31-60 years (39.7%). Most of the respondents graduated from elementary school (58.8%) with the most occupation being fishermen. The source of drinking water used by respondents is dug well water and drinking water is mostly treated by boiling.

The results of the measurement of the concentration of heavy metal cadmium (Cd) in water samples in Table 2 show that the laboratory examination of the concentration of cadmium (Cd) in drinking water sources at each point is the same, namely < 0.0002 mg/l. The concentration of Cd does not exceed the maximum allowed according to the Regulation of the Minister of Health No. 492 of 2010 amounting to 3 x 10-3 mg/locations for environmental sampling or groundwater samples are a group of Spermonde islands which have a close location, population and island area.

Table 3 shows the rate of water consumption intake ranges from 1 - 2 L / day. The frequency of exposure
ranges from 358 days - 365 days / year. The age of respondents ranged from 3 years - 78 years. The highest body weight of respondents was 90 kg and the lowest body weight was 11 kg.

Table 4. Intake (I) and Risk Level (RQ) Non-carcinogenic exposure to Cadmium (Cd) at Drinking Water Sources on Kodingareng Lompo Island

<table>
<thead>
<tr>
<th>Variable</th>
<th>Min</th>
<th>Max</th>
<th>Median</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intake (I) 30 years</td>
<td>0.0000</td>
<td>0.0000</td>
<td>0.000000</td>
<td>0.000007</td>
</tr>
<tr>
<td>Risk Quotient (RQ) 30 years</td>
<td>0.0095</td>
<td>0.0338</td>
<td>0.012666</td>
<td>0.014046</td>
</tr>
</tbody>
</table>

Table 4 shows the estimated intake (I) of respondents in Kodingareng Lompo Island with a minimum value of 0.00000048 and a maximum intake value (I) of 0.000169. With an average of 0.000007014. The level of risk / Risk Quotient (RQ) of non-carcinogenic Cd obtained on average is 0.014046046. Based on the results of the RQ calculation, it shows that the local community is safe or not at risk of exposure to heavy metal Cd because the RQ value 1. The estimated risk is calculated for the default duration of life (lifetime) of 30 years.

Table 5. Intake (I) and Risk Level (RQ) Non-carcinogenic exposure to Cadmium (Cd) at Drinking Water Sources on Barrang Lompo Island

<table>
<thead>
<tr>
<th>Variable</th>
<th>Min</th>
<th>Max</th>
<th>Median</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intake (I) 30 years</td>
<td>0.0000</td>
<td>0.0000</td>
<td>0.000006</td>
<td>0.000007</td>
</tr>
<tr>
<td>Risk Quotient (RQ) 30 years</td>
<td>0.0084</td>
<td>0.0345</td>
<td>0.013818</td>
<td>0.014976</td>
</tr>
</tbody>
</table>

Table 5 shows the estimated intake (I) of respondents in Barrang Lompo Island with a minimum value of 0.0000042 and a maximum value of intake (I) of 0.0000173. With an average of 0.000007488. The level of risk / Risk Quotient (RQ) of non-carcinogenic Cd obtained on average is 0.014976597. Based on the results of the RQ calculation, it shows that the local community is still safe or not at risk of exposure to heavy metal Cd because the RQ value 1. The estimated risk is calculated for the default duration of life (lifetime) of 30 years.

Table 6. Intake (I) and Risk Level (ECR) Carcinogenic exposure to Cadmium (Cd) at Drinking Water Sources on Kodingareng Lompo Island

<table>
<thead>
<tr>
<th>Variable</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Median</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intake (I) 70 years</td>
<td>4.750E-06</td>
<td>1.694E-05</td>
<td>6.333E-06</td>
<td>7.022E-06</td>
</tr>
<tr>
<td>Excess Cancer Risk (ECR) 70 years old</td>
<td>2.541E-004</td>
<td>7.125E-005</td>
<td>9.500E-005</td>
<td>1.053E-004</td>
</tr>
</tbody>
</table>

Table 6 shows the estimated intake (I) of respondents in Kodingareng Lompo Island with a minimum value of 4.750E-006 and a maximum intake value (I) of 1.694E-005. With an average of 7.022E-006. The level of risk / Excess Cancer Risk (ECR) of carcinogenic Cd obtained on average was 1.053E-004. Based on the results of the ECR calculation, it shows that the local community is safe or at risk of exposure to heavy metal Cd because the ECR value is > 1. The estimated risk is calculated for the default duration of life (lifetime) 70 years.

Table 7. Intake (I) and Risk Level (ECR) Carcinogenic exposure to Cadmium (Cd) at Drinking Water Sources on Barrang Lompo Island

<table>
<thead>
<tr>
<th>Variable</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Median</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intake (I) 70 years</td>
<td>4.222E-006</td>
<td>1.727E-005</td>
<td>6.909E-006</td>
<td>7.488E-006</td>
</tr>
<tr>
<td>Excess Cancer Risk (ECR) 70 years old</td>
<td>6.333E-005</td>
<td>2.591E-004</td>
<td>1.036E-004</td>
<td>1.123E-004</td>
</tr>
</tbody>
</table>

Table 7 shows the estimated intake (I) of respondents in Kodingareng Lompo Island with a minimum value of 4.222E-006 and a maximum value of intake (I) of 1.727E-005. With an average of 7.488E-006. The level of risk / Excess Cancer Risk (ECR) of carcinogenic Cd obtained on average was 1.123E-004. Based on the results of the ECR calculation, it shows that the local community is not safe or at risk of exposure to heavy metal Cd because the ECR value is > 1. The estimated risk is calculated for the default duration of life (lifetime) 70 years.
Carcinogens Excess Cancer Risk (ECR) In Kodingareng Island and Barrang Lompo

Table 8. Distribution of Respondents by Category That Has Risk of Excess Cancer Risk (ECR) In Kodingareng Island and Barrang Lompo

<table>
<thead>
<tr>
<th>Location</th>
<th>Age Group</th>
<th>ECR Cd 70 Years</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Not Safe</td>
<td>Safe</td>
</tr>
<tr>
<td>P. Kodingareng</td>
<td>Children</td>
<td>n 3</td>
<td>1</td>
</tr>
<tr>
<td>Lompo</td>
<td>(75%)</td>
<td>(25%)</td>
<td>(100%)</td>
</tr>
<tr>
<td>Adult</td>
<td>n 12</td>
<td>19</td>
<td>(100%)</td>
</tr>
<tr>
<td></td>
<td>(38.7%)</td>
<td>(61.3%)</td>
<td>(100%)</td>
</tr>
<tr>
<td>P. Barrang</td>
<td>Children</td>
<td>n 6</td>
<td>0</td>
</tr>
<tr>
<td>Lompo</td>
<td>(100%)</td>
<td>(0%)</td>
<td>(100%)</td>
</tr>
<tr>
<td>Adult</td>
<td>n 12</td>
<td>15</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td>(44.4%)</td>
<td>(55.6%)</td>
<td>(100%)</td>
</tr>
</tbody>
</table>

Table 8 shows the risk categories in the age group of children and adults who have an unsafe and safe risk based on the calculation of Excess Cancer Risk (ECR). The level of unsafe carcinogenic risk on Kodingareng Island in the children's age group was 75% and 38.7% in the adult age group, while on Barrang Lompo Island in the children's age group it was 100% and 44.4% in the adult age group. The estimated risk is calculated for a default duration of 70 years and categorized by age group. The risk level of respondents differed based on the value of intake rate, body weight, concentration, frequency of exposure, duration of exposure and body weight. The heavier a person is, the smaller the health risk from the intake of chemicals that enter the body.

Discussion

Concentration (C) of Cadmium (Cd) in People's Drinking Water Sources

Shallow groundwater is the main water reserve which is very important for small islands located far from the mainland. The presence of groundwater indirectly can guarantee high water quality, this is because the groundwater used is shallow groundwater (wells) which is groundwater that is easily contaminated through seepage either from shelters or garbage disposals, septic tanks or sewage disposal sites. Humans and animals are even caused by geological formations that move to that place (Wulan, 2016 in Hamzar, 2021). This is in line with research (Syamsir, 2015), which suggests that shallow groundwater such as borehole water and dug well water in several small islands of Makassar City is contaminated with domestic waste, one of which is because the distance between the polluter and the well does not meet the requirements. In addition, the depth of the well also affects the groundwater pollution index. Shallow groundwater is more susceptible to contamination with pollutants than deep groundwater. Drinking water is a well-known route of exposure as a medium for heavy metal exposure. Many heavy metals have received attention as environmental contaminants and potential hazards, such as cadmium (Cd), chromium (Cr) and lead (Pb). Exposure to heavy metals is one of the factors that play a role in influencing the quality of clean water. To estimate the level of risk that can occur, an ARKL research was carried out referring to the ARKL Technical Guidelines made by the Director General of P2PL of the Ministry of Health in 2012.

Drinking water consumed by the community has the potential to be contaminated, especially in dug well water. The measurement results of heavy metal cadmium (Cd) in drinking water sources are <0.0002 mg/l. Environmental sampling consisted of 6 sampling points with each coordinate point, namely sample 1 (S5° 8' 21,7282" E119° 15' 58, 82955), sample 2 (S5° 8' 45,09671" E119° 15' 56, 39857), sample 3 (S5° 8' 51,24997" E119° 15' 53.52331), sample 4 (S5° 2' 56,33819" E119° 19' 45,57727), sample 5 (S5° 2' 54,56437" E119° 19' 40.59299) and sample 6 (S5° 3' 2.11245" E119° 19' 44.12737). The concentration of heavy metals at the point of the well does not exceed the quality standard, namely Cd 0.005 mg/l. The concentration of Cd does not exceed the maximum allowed according to the Regulation of the Minister of Health No. 492 Year 2010 is 3 x 10-3 mg/l. The entry of heavy metals into groundwater through nature (geogenic) and or community domestic activities (anthropogenic), routine testing of the quality of drinking water sources is important (Oloruntoba et al, 2021). Heavy metals that enter the human body are harmful to health. Heavy metals can block the work of enzymes so that the body's metabolism is disrupted, causing cancer and mutations (Pratiwi, 2020). The potential carcinogenic and non-carcinogenic effects of heavy metals in drinking water were measured through guidelines developed by the United States Environmental Protection Agency (USEPA) based on the route of exposure (US Epa 1989). Non-essential heavy metals (micro elements) have no function in the human body and are even very dangerous to cause poisoning (toxic) to humans including lead (Pb), mercury (Hg), arsenic (As) and cadmium (Cd) (Adhani and Husaini 2017). Cadmium (Cd) is the most toxic heavy metal element even at low concentrations. High Cd exposure can cause bone damage, cancer, diarrhea, hair loss, kidney damage, dermatitis, impaired kidney function and depression (Koki et al., 2015).
The average concentration of Cd from the research results has not exceeded the threshold value of cadmium concentration (Cd). However, if there is an increase in the concentration of Cd in the water, it is not impossible to increase the level of risk and cause health problems for humans. This condition can occur if there is an increase in the amount or volume of wastewater entering the water body. However, the health risk assessment is not only influenced by the value of the concentration of pollutants in the water but also takes into account other influencing factors such as the characteristics of the respondents in the research location. In addition, other variables such as body weight, intake rate, exposure time, duration of exposure, exposure frequency also greatly affect the calculation of risk analysis. If the concentration value of a pollutant agent is below the threshold, it cannot be concluded that the concentration is safe for exposed humans. This is in line with research Dewi et al (2016) where the duration of exposure affects the intake value where the longer the consumption of drinking water from the well, the higher the intake value (I) and the risk of adverse health effects is also greater. Boiling and disinfecting water kills most disease-causing microorganisms that may be present in the water. However, boiling or disinfecting will not destroy other contaminants, such as heavy metals, salt, and most other chemicals (USEPA, 2017). It is important to know that boiling is ineffective or insufficient to reduce the risk (WHO, 2017). The response of boiling water is not appropriate when there is chemical contamination. This can increase exposure to chemicals such as nitrates and solvents by concentration in boiled water or by evaporation into the respiratory zone. Boiling water is also inappropriate for dealing with gross contamination levels such as raw sewage or high turbidity (Department of Health New York State, 2018).

**Distribution of Average Intake Rate (R) cd and Weight (BB) Respondents**

According to the ARKL theory written in the Environmental Health Risk Analysis guidebook, it is said that the average weight for Asian/Indonesian adults is 55 kg. However, the average weight of a normal adult in Europe is 70 kg. From the results of research conducted, it can be seen that the average body weight of the respondents is 55 kg. These values indicate that the average body weight of the respondents in this study is the same as the weight of normal Asian adults and smaller than the average weight of normal European adults. In this study, the value of weight is inversely proportional to the value of the risk, where the lower the weight value of a respondent, the higher the value of the risk to the respondent. This is the same as research conducted by researchers who state that respondents with weight values above the average have a lower risk value compared to respondents who weigh below the average value. Another study which states that this was done by researchers that the ARKL method does not only rely on the weight variable, but there are still other variables that play a role in influencing the results of the RQ and or ECR obtained.

**Distribution of Average Frequency of Exposure (Day/Year) to Cd in Drinking Water Sources**

The frequency of exposure is the number of days in a year where the respondent lives or is in the research location and uses well water to meet drinking water needs. The frequency of exposure received by respondents in this study ranged from 358-365 days. As stated by the researcher, the risk received by the respondent is determined by the frequency of exposure received, where the greater the frequency with which a person is exposed to hazardous substances in the air in one year, the greater the health risk that will be received.

**Intake (I) Value and Non-Carcinogenic and Carcinogenic Risk Levels of Cd Exposure**

Intake value is the value of the actual dose of a risk agent received by a respondent every day per kilogram of body weight. The greater a person’s weight, the smaller the health risk from the intake of chemicals that enter his body. This happens because there are differences in the speed of metabolism by chemicals that enter the body based on differences in body weight. Therefore, it can be interpreted that the greater the value of the intake rate of Cd exposure in a person is strongly influenced by concentration, intake rate, exposure time, exposure frequency, duration of exposure and body weight. This study uses the calculation of the rate of intake with a lifetime exposure duration of 30 years for non-carcinogenic values and a lifetime of 70 years for carcinogenic values. Univariate analysis is used to determine whether or not the distribution of research variable data is normal. The test used in this analysis is the Shapiro-Wilk test for the variable concentration of heavy metals because...
the amount of data is <50, while for the variable frequency, and duration whose data is 50, the Kolmogorov-Smirnov test is used. Based on the results of the study that the level of risk / Risk Quotient (RQ) of non-carcinogenic Cd in the calculation of the value of the Risk Quotient (RQ) in Kodingareng and Barrang Lompo Islands indicates that the local community is still safe or not at risk of exposure to heavy metal Cd because the RQ value 1. This risk estimate is calculated for the default duration of life (lifetime) of 30 years, while the calculation of the carcinogenic ECR risk level indicates that the local community is not safe or at risk of exposure to heavy metal Cd because the ECR value is > 1 in the age group of children and adults. The estimated risk is calculated for a default duration of 70 years. Respondents' risk level was different based on the value of intake rate, body weight, concentration, frequency of exposure, duration of exposure and body weight. The heavier a person is, the smaller the health risk from the intake of chemicals that enter the body. This research in line with (Khalid et al., 2020) showed that as many as 129 groundwater samples were obtained and analyzed for heavy metal concentrations (lead, copper, cadmium, nickel, manganese, chromium, iron, and zinc). In addition, pH, electrical conductivity, temperature, total dissolved solids, and the content of anions (carbonates, chlorides, and bicarbonates) and cations (calcium, potassium, sodium, lithium, and barium). The risk assessment estimates a potential non-carcinogenic risk of Cd (0.0007-0.03mg/l) with an HQ value < 1 but at a Pb concentration it has a potential non-carcinogenic risk with an HQ value > 1. The study findings emphasize the need for an appropriate approach to recover groundwater before being used as a source of drinking water. The presence of toxic substances in aquifers, especially potentially toxic heavy metals, is an important environmental and social problem worldwide. These heavy metals are capable of providing many adverse health effects on humans by drinking metal-contaminated water.

Risk control by using an approach to reducing the concentration of heavy metals in drinking water sources can be done by calculating the safe concentration of heavy metals in drinking water sources if consumed or used every day for a certain period of time. Where the determination of safe levels of heavy metals can vary for each individual depending on the length of contact (duration of exposure) and a person's body weight. Reduction of heavy metal concentrations can be done by processing drinking water sources at the location with several methods that can be applied. The development of efficient and suitable technologies for the removal of heavy metals from water is required. Several methods have been used to remove heavy metals from contaminated water such as chemical precipitation, ion exchange, adsorption, membrane filtration, reverse osmosis, solvent extraction, and electrochemical treatment. Many of these methods are costly and operational. Adsorption seems to be one of the most suitable methods, due to its high efficiency, low cost and ease of operation (Wołowiec et al., 2019).

Conclusion

The risk of lifetime exposure to cadmium (Cd) due to consumption of well water as a source of drinking water on public health in Kodingareng and Barrang Lompo Islands is RQ 1, meaning that it is still safe or not at risk of having non-carcinogenic health problems for the next 30 years, while the risk of exposure is high. Lifetime cadmium (Cd) due to consumption of well water as a source of drinking water on public health in Kodingareng and Barrang Lompo islands, namely ECR > 1, meaning unsafe or at risk of having carcinogenic health problems for up to 70 years into the future. It is necessary to monitor the quality of well water continuously and in-depth assessment of exposure to cadmium (Cd) and other dangerous heavy metals in relation to at-risk populations through active roles and synergy between local stakeholders.

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