Heavy Metals in Water Collected from Water-harvesting Ponds (Haffirs), Gedarif State, Eastern Sudan

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Abstract

Water quality is a great concern. The heavy metals (HMs) levels in the water-harvesting ponds (haffirs) water may cause serious health problems, including cancers. This study investigated the concentration of 13 HMs in haffir water in Gedarif State, Eastern Sudan where the inhabitants completely dependent on them (drinking, washing, bathing, irrigation, etc.). Three locations and types of haffirs will were selected for this study, and 24 water samples were collected in plastic bottles were collected from July 2015 to Feb. 2016; preserved by adding of 2 - 3 drops of nitric acid. These samples were subjected to analysis for Cu, Fe, Zn, Mo, Ni, Cr, Pb, Co, V, Sr and Cd, Mn, Ti by using Inductively Coupled Plasma optical emission (ICP-OE). The obtained concentrations were compared with drinking water quality limits given by the WHO. This indicated that haffir water is highly toxic for haffir water samples were found to be enriched and polluted which may as a consequence of human and animal activities and Municipal waste. Around 200m from the stream (khour) in this area, significant differences were detected between haffirs at (p < 0.05). The results for the three haffirs regarding Pb were ranging between 1.08 - .269 ppm, for Cu from 0.462 - 1.49 ppm, Zn from 0.021 - 0.148 ppm, Fe from 2.5 - 9.16 ppm, Co 0.0018 ppm, Cd 0.0009 ppm, Mn² from 1.13 - 2.191 ppm, Ni from .0076 - 0.085 ppm, Mo from 0.054 - 0.51 ppm, Sr from 0.4 - 4.37 ppm, V from 0.017 - 0.029 ppm and Ti from (0.004 - 0.007 ppm, Cr from 0.0013.0 - 0.0031 ppm. Pb, Fe, Mn, V, Ti and Sr were higher than their permissible limits (PLs) according to WHO (2004) for the three haffirs.

Keywords: Water Harvesting Ponds; Heavy Metal; Water Contamination; Gedarif; Sudan

Introduction

Water dominates all life activities, such as domestic uses and food production. Therefore, it is worldwide concern. The water consumption throughout the globe is steadily increasing, while the freshwater available, due to the pollution and mismanagement, is decreasing. To provide drinking water for humans, animals, as well as for many other purposes, water-harvesting (WH) should be carefully implemented. In the Sudan, there is a very strong relationship between availability of water, poverty and health. The possible solution of the latter situation is the rainwater harvesting (RWH). Two unique indigenous RWH systems experienced in the Sudan, which are not found elsewhere in the world: (i) Collected rainwater is stored in the stem of a huge tree called Baobab tree (local name Tabaldi), (ii) Cultivate large areas by local cultivar of watermelons, which is stored to be used for drinking, eating and seeds production for local consumption.

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and export during the dry-season in Western Sudan [1]. However, the rural people in Eastern and western Sudan store rainwater in water-harvesting ponds (locally called haffirs). A haffir is an artificial excavation into which surface water from rains is collected to be stored and used during the dry-season. The size of haffirs depends on location, hydrology, soils and rainfall. The size ranges between 5,000 and 30,000m³. There are two traditional and standard types of haffirs. Traditional haffirs go back to >100 yr ago. Standard haffirs were developed using modern engineering designs and modifications. Standard haffirs are provided with stilling pool, inlet and outlet valves, energy dissipater, embankments, pump units, filters and drainage canal to be used for drinking by humans and animals [2]. Winds or water runoff from distant places usually carry soil particles, transports and deposits them in the haffirs throughout the year. Fertilizers (phosphorus, nitrogen, and potassium), pesticides (insecticides and herbicides), manure, sludge and crop residues, minerals, salts and heavy metals (HMs) are some of the expected items to be deposited in the haffirs. Gedarif is an agricultural state grows around 10 million acre/yr depending on rains from July to October.

HM (e.g. Hg, Pb, Cd, Z, Cr, and Cu) is a general collective term, which applies to the group of metals and metalloids with atomic density > 4000 kgm⁻³ or 5x more than water [3]. Although some of HMs act as essential micronutrients for living beings, at higher concentrations they can lead to severe poisoning [4]. In the environment, the HMs are generally more persistent and stable than organic contaminants, e.g. pesticides or petroleum by-products and are non-biodegradable [5]. The environmental pollution by HMs comes from anthropogenic sources, e.g. smelters, mining, power stations and the application of pesticides containing metal, fertilizer; sewage sludge and the irresponsible disposal of wastes by various industries [6]. HMs can become mobile in soils, depending on soil pH and their speciation. So, a fraction of the total mass can leach to aquifer or can become available to living organisms [6]. HMs have, due to the excessive use and dumping at high concentrations, become toxic to both human and microbes [7]. Natural waters contamination deserves large attention not only due to its environmental hazardous effects, but also for the risks to the human and animal health, as well as the economical damages it produces. Between the wide diversity of pollutants affecting water resources, HMs receive particular concern considering their strong toxicity even at low concentrations. The occurrence of HMs in water bodies can be of natural origin (i.e. eroded minerals within sediments, leaching of ore deposits, and volcanism extruded products) or for anthropogenic one (i.e. solid waste disposal, industrial or domestic effluents, harbor channels dredging) [8].

Ground water (GW) and surface water (SW) are important and major sources of drinking water in both urban and rural areas in the Sudan. Determination of water quality is one of the most important aspects in GW studies. GW is highly valued because of certain properties not possessed by SW [9,10]. People around the world have used GW as a source of drinking water; and even today more than half the world’s population depends on GW for survival. The value of GW lies not only in its widespread occurrence and availability, but also in its consistent good quality, which makes it an ideal source of drinking water. In recent times, increasing focus is being given to studies on GW contamination. Since GW is directly in contact with soil, rocks and plants, the constituents of these sources might contaminate the GW [11]. Trace elements constitute a natural component of the earth crust and they are not biodegradable, hence, persist in the environment. Trace elements may come from natural sources, leached from rocks and soils according to their geochemical mobility or come from anthropogenic sources, as the result of human land occupation and industrial pollution [12]. Depending on their solubility, these metals may eventually become associated with suspended particulate matter and accumulate in the bottom sediments. The increase of industrial activities has intensified environmental pollution problems and the deterioration of several aquatic ecosystems with the accumulation of metals in biota and flora. However, at higher concentrations of HMs can lead to poisoning and they have ability to be incorporated into food-chains.

Materials and Methods

Study area

This study was conducted in Gedarif State (75,000 km²), eastern Sudan between latitude (14 - 16 N and 33 - 36 E longitude). Gedarif state plays a significant role in the economy and agricultural products of the country. The state is divided in to 12 administrative localities.
The population is estimated as 1,827. The majority (65.9%) of the population works in rain-fed agriculture. The vegetation of the state is poor savannah. The soil is clay and muddy. There are several rivers that pass through the state. Average of the rainfall is approx. 612 mm. Several mountains and forests are scattered throughout the state. Safe water is available in towns and big villages with some shortage from March to June. But in rural and agricultural areas, people depend on large water reservoirs (Haffirs) [13].

**Samples collection**

Samples (24/ haffir), collected from July to February, from Elazaza, Tarfa and Kafay haffirs in plastic bottles. After filtration, 10% nitric acid (2 ml conc. HNO₃) was added. The samples were stored at 1 - 4°C.

**Sample preparation**

The pH of the water sample was adjusted to 3.6 ± 0.1 using 10M HCl. From the samples, 100 ml was transferred to a conical flask; 5ml of 65% conc. nitric acid and some boiling chips were added, evaporated using hot-plate to about 10 to 20 ml or before the appearance of a precipitate. Heating continued with the addition of conc. HNO₃ until digestion is completed as indicated by light color and clear solution. Clean up was performed by washing the beaker wall with distilled water (DW), followed by filtration. The filtrate was transferred to 100 ml volumetric flask with 5 ml portions of water for rinsing, cooled and diluted to the mark. Then analyzed by ICP-OES [14].

**Reagents**

The reagents required for this work were as follows: conc. nitric acid (65% HNO₃), boiling chips, filter papers (Whatman 42), deionized water (DIW), DW, Argon gas (99.99 purity), Pb, Cu, Zn, Fe, Co, Cd, Mn, Ni, Mo, Ti, V, Sr and Cr Standards for AAS (Sigma; 1000 ppm).

**Instruments and glassware**

Volumetric flasks (different sizes), hot plates, plastic bottles, measuring cylinders of different sizes, conical flasks, different sizes of pipettes, test tubes, oven, pH meter, digital sensitive balance and Inductivity Coupled Plasma (ICP-OES 725 ES).

**Operating conditions**

ICP-OES, Varian, 725-ES Simultaneous, with background correction, auto-fit multi-calibration curve fitting, signal to background ratio (SBR) and signal to root background ratio. Power = 1.2 KW Plasma, Plasma Flow = 15 L/min, Aux. Flow = 1.5 L/min, Neb. Flow = 0.75 L/min, Replicate read time (S) =10 S. Sample Uptake time = 30S. Rinse Time = 25S, Pump rate = 15 rpm and Instrument stabilization delay = 15S.

**Preparation of standards**

The stock solution of the standards (Std) was prepared from mixed standards named Stock Solution A (SSA) and Stock Solution B (SSB; Table 1).

**Mixed standards SSA**

- **Group I (Al, Ba, Sr, Zn, Pb):** Volume taken was 8 ml from 1,000 µg/mL for each element.
- **Group II (Ag, Co, Cu, Cr, Mn, Ni, Li):** Volume taken was 4 ml from 1,000 µg/ml for each element
- **Group III (Cd, As, V, Mo, Sb, Ti, B, Be, Se):** Volume taken was 2 ml from 1,000 µg /ml for each element.

The total volume for the three groups combined was 86 ml. This was completed to 200 ml with DIW to yield 40, 20, 10 µg/ml, respectively or groups I to III (Table 1).

**Mixed standards SSB**

- **Group IV (Na, K, Ca):** Volume taken 40 ml from 1000 µg/ml for each element.

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- **Group V (Fe, Mg):** Volume taken 20 ml from 1000 µg/ml for each element.
- **Group VI (P, Si):** Volume taken 10 ml from 1000 µg/ml for each element.

The total volume was 180 ml (combined) and completed to 200 ml with DIW to yield 200, 100 and 50 µg/ml, respectively, for groups IV to VI (Table 1).

<table>
<thead>
<tr>
<th>Standard Mixture (SM)</th>
<th>Groups</th>
<th>Volume taken (ml) from 1,000 (µg/mL)</th>
<th>Final volume (ml)</th>
<th>Conc. of Group. (µg/mL)</th>
<th>Shelf life of Standard (Months)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>I</td>
<td>8</td>
<td>200</td>
<td>40</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>II</td>
<td>4</td>
<td></td>
<td>20</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>III</td>
<td>2</td>
<td></td>
<td>10</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>IV</td>
<td>40</td>
<td>200</td>
<td>200</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>V</td>
<td>20</td>
<td></td>
<td>100</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>VI</td>
<td>10</td>
<td></td>
<td>50</td>
<td>6</td>
</tr>
</tbody>
</table>

*Table 1: The standard mixtures A (SMA; I to III) and B (SMB; IV to VI) groups for the HMs tested.*

**Preparation of calibration standards dynamics range**

These standards were prepared as in table 2.

<table>
<thead>
<tr>
<th>Standard</th>
<th>Volume taken (ml)</th>
<th>Final Volume (ml)</th>
<th>Validity (month)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>100 of Std3</td>
<td>200</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>100 of Std4</td>
<td>200</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>100 of Std5</td>
<td>200</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>5 of SSA+ 10 of SSB</td>
<td>200</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>10 of SSA+ 20 of SSB</td>
<td>200</td>
<td>3</td>
</tr>
</tbody>
</table>

*Table 2: Preparation of calibration standards.*

The concentrations of the elements were prepared to obtain the following: Group (1): 125 ppb from 250 ppb; Group (11): 62.5 ppb; Group (111): 31.5 ppb; Group (1V): 1.25 ppb; Group (V): 0.625 ppb and Group (V1): 0.3123 ppb. (Std1).

**Preparation of blanks**

*The calibration blank (CB):* CB was prepared by diluting 10 ml of conc. nitric acid in 1000 ml DIW. Sufficient quantity was prepared for flushing the system between standards and samples.

**Chemical analysis**

The prepared water samples were placed in the glass-stoppered test tubes to introduce the samples into the ICP-OE for reading the spectra automatically to determine the concentration of the above-mentioned in the screen. Glassware was thoroughly cleaned, rinsed with water, 1% nitric acid and DIW prior to use. A blank and duplicate were included with each batch. Control Procedure for the number and type of checks required for the determination of trace elements by ICP-OES were considered. Quality Control Check sample as per IQC schedule were adopted when required.

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Data analysis

The data was subjected to ANOVA using the SAS statistical package (SAS 2004), and the means were separated by Duncan’s Multiple Range Test.

Results

Azaza haffir

The HM concentration in the water samples collected from July to Feb. in Azaza haffir showed Pb concentrations of 1.08 ppm (0.609 - 1.83 ppm), whereas the PL is 0.01 ppm; Cu 1.29 ppm (range: 1.27 - 1.36 ppm) and the PL is 2 ppm; Zn PL is 0.2 ppm and the detected level was 0.148 ppm (0.133 - 0.179 ppm); Fe mean was 3.06 ppm (2.752 - 3.95 ppm) and the PL is 0.5 ppm; Co mean was 0.0018 ppm (0.0018 - 0.0018 ppm), whereas the PL is 0.0003 ppm; Cd mean was 0.0009 ppm (0.0009 - 0.0009 ppm) and the PL is 0.0003 ppm. However, Mn mean was 2.19 ppm (1.02 - 3.478 ppm) and its PL is 0.4 ppm; Ni 0.0624 ppm (0.051 - 0.079 ppm), its PL is 0.07 ppm, whereas the mean for Mo was 0.054 ppm (0.0178 - 0.068 ppm) and the PL is also 0.07 ppm, Ti 0.0039 ppm (0.0034 - 0.0064 ppm), the PL 0.001 ppm, the V mean was 0.0192 ppm (0.0133 - 0.0219 ppm), the PL is 0.0003 ppm and finally Sr mean concentration was 4.375 ppm (4.091 - 4.987 ppm) the PL is 0.02 ppm and Cr 0.0013 ppm (0.0013 - 0.0013 ppm) (Table 3) the PL is 0.02 ppm.

<table>
<thead>
<tr>
<th>HM</th>
<th>Azaza (ppm) (Mean ± SE)</th>
<th>C.V.%</th>
<th>Tarfa (ppm) (Mean ± SE)</th>
<th>C.V.%</th>
<th>Elkafay (ppm) (Mean ± SE)</th>
<th>C.V.%</th>
<th>WHO 2014 (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pb</td>
<td>1.08 ± 0.21</td>
<td>4.35</td>
<td>2.15 ± 0.41</td>
<td>14.9</td>
<td>0.27 ± 0.021</td>
<td>0.89</td>
<td>0.01</td>
</tr>
<tr>
<td>Cu</td>
<td>1.291 ± 0.100</td>
<td>16.6</td>
<td>1.492 ± 0.107</td>
<td>18.6</td>
<td>0.462 ± 0.007</td>
<td>9.6</td>
<td>2.0</td>
</tr>
<tr>
<td>Zn</td>
<td>0.148 ± 0.0133</td>
<td>12.9</td>
<td>0.37 ± 0.0123</td>
<td>13.7</td>
<td>0.0207 ± 0.00123</td>
<td>12.27</td>
<td>0.2</td>
</tr>
<tr>
<td>Fe</td>
<td>3.17 ± 0.172</td>
<td>2.4</td>
<td>9.16 ± 0.472</td>
<td>4.2</td>
<td>2.5 ± 0.037</td>
<td>1.24</td>
<td>0.5</td>
</tr>
<tr>
<td>Co</td>
<td>0.00180 ± 0.00001</td>
<td>25</td>
<td>0.00180 ± 0.00003</td>
<td>24</td>
<td>0.0018 ± 0.00001</td>
<td>15</td>
<td>0.0003</td>
</tr>
<tr>
<td>Cd</td>
<td>0.0009 ± 0.0001</td>
<td>14</td>
<td>0.00089 ± 0.00001</td>
<td>21</td>
<td>0.00089 ± 0.00001</td>
<td>13</td>
<td>0.003</td>
</tr>
<tr>
<td>Mn²⁺</td>
<td>2.19 ± 0.193</td>
<td>31.8</td>
<td>1.51 ± 0.185</td>
<td>31.0</td>
<td>1.13 ± 0.174</td>
<td>30.8</td>
<td>0.4</td>
</tr>
<tr>
<td>Ni</td>
<td>0.049 ± 0.00044</td>
<td>40</td>
<td>0.085 ± 0.00443</td>
<td>45</td>
<td>0.0076 ± 0.000443</td>
<td>30</td>
<td>0.07</td>
</tr>
<tr>
<td>Mo</td>
<td>0.054 ± 0.0009</td>
<td>9.3</td>
<td>0.064 ± 0.00095</td>
<td>9.5</td>
<td>0.051 ± 0.0009</td>
<td>9.1</td>
<td>0.07</td>
</tr>
<tr>
<td>Ti</td>
<td>0.004 ± 0.0004</td>
<td>43.5</td>
<td>0.007 ± 0.0006</td>
<td>45.1</td>
<td>0.006 ± 0.0007</td>
<td>40.1</td>
<td>0.001</td>
</tr>
<tr>
<td>V</td>
<td>0.029 ± 0.002</td>
<td>11.7</td>
<td>0.002 ± 0.0002</td>
<td>11.1</td>
<td>0.002 ± 0.0001</td>
<td>10.3</td>
<td>0.0003</td>
</tr>
<tr>
<td>Sr</td>
<td>4.37 ± 0.39</td>
<td>24</td>
<td>1.267 ± 0.32</td>
<td>14.3</td>
<td>0.14 ± 0.29</td>
<td>13.9</td>
<td>0.02</td>
</tr>
<tr>
<td>Cr</td>
<td>0.0013 ± 0.0001</td>
<td>6.5</td>
<td>0.00199 ± 0.0001</td>
<td>2.5</td>
<td>0.0031 ± 0.0001</td>
<td>5.5</td>
<td>0.05</td>
</tr>
</tbody>
</table>

Table 3: Concentration of HMs (ppm) of the three haffirs water from July to February.

Tarfa haffir

The concentrations in this haffir, within the same period, were as follows: Pb mean 2.15 ppm (range: 0.909 - 3.358 ppm); Cu 1.492 ppm (1.012 - 1.993 ppm); Zn 0.37 ppm (0.22 - 0.69 ppm); Fe 9.16 ppm (9.137 - 9.231 ppm); Co 0.0018 ppm (in all samples); Cd 0.0009 ppm (in all samples); Mn 1.51 ppm (0.56 - 1.97 ppm); Ni 0.085 ppm (0.055 - 0.121 ppm); Mo 0.064 ppm (0.062 - 0.072 ppm); Ti 0.007 ppm (0.0034 - 0.0164 ppm); V 0.017 ppm (0.015 - 0.019 ppm); Sr 1.267 ppm (1.737 - 2.767 ppm) and Cr 0.0161 ppm (0.0013 - 0.0023 ppm).

Elkafay haffir

Similarly, the results in this haffir were as follows: Pb mean 0.27 ppm (range: 0.242 - 0.383 ppm); Cu 0.462 ppm (0.262 - 0.66 ppm); Zn 0.0207 ppm (0.011 - 0.0371 ppm); Fe 2.5 ppm (2.14 - 2.753 ppm); Co 0.00018 ppm (all samples); Cd 0.00089 ppm (all samples); Mn
1.13 ppm (0.825 - 1.397 ppm); Ni 0.008 ppm (0.065 - 0.0099 ppm); Mo 0.051 ppm (all samples), Ti 0.006 ppm (0.006 - 0.007 ppm); V 0.002 ppm (0.016 - 0.0022 ppm); Sr 0.14 ppm (0.104 - 0.194 ppm) and Cr 0.0031 ppm (0.0009 - 0.0024 ppm).

**Discussion**

The three haffirs showed very high levels of Pb, compared to the WHO 2014 PLs (0.1 ppm). Tarfa haffir showed the highest level (2.15 ppm), followed by Azaza haffir (1.08 ppm), and the lowest was that of Elkafey (0.27 ppm). However, Cu was lower than the PLs (2.0 ppm); Elkafey was also the lowest and the highest was, again, that of Tarfa. Tarfa also registered the highest concentration of Zn (0.37 ppm) and Elkafey the lowest; the PL is 0.2 ppm. Very high levels of Fe were reported in the three sites (from 5x -19x), compared to the PL (0.5 ppm). Tarfa showed 9.6 ppm, Azaza 3.17 and Elkafey 2.5 ppm. The PL for Co is 0.0003 ppm, whereas the three sites registered 6x of that level. On the other hand, the PL for Cd is 0.003 ppm and the three sites also were higher by 3x. Mn was also higher than the PL (0.4 ppm) in the three sites ranging between 1.31 to 2.19, the lowest was that of Elkafey and the highest was that of Azaza haffir: The Ni PL is 0.07; Elkafey haffir concentration was by far very low (0.007ppm), Azaza was 0.04, whereas Tarfa was the only haffir that registered 0.08, which was higher than the PL. The PL for Mo is also 0.07 ppm; the three haffirs registered levels slightly lower than the PL. Ti was high in the three haffir (4-7x), the highest was that of Tarfa; the PL is 0.001 ppm. V PL is 0.0003 ppm; Tarfa and Elkafey registered 0.002 ppm (6.6x), whereas Azaza registered very high level (0.029 ppm; 96.6x). Finally, for Sr, the three haffir showed very high concentrations compared to the PL which is 0.02 ppm. The lowest was found in Elkafey (0.14 ppm; 7x), the higher was that of Azaza (4.37 ppm; 218.5x).

The results from Merowe Locality followed the same trend. High concentrations of Pb, Ni, Cd and Fe were detected in the RDW samples (4.7, 14.495, 0.0131and 0.325 ppm, respectively); these levels were higher than those of WHO (2004) limits. The samples of TW in Merowe also showed presence of high levels of Pb, Ni, Cd, Fe and Hg. Their levels were 4.72, 18.33, 0.012, 0.37 and 0.002, ppm, following the same order. The UGW samples reflected the presence of high concentrations of Pb, Co, Ni, Cd, Cr, and Hg (2.84, 2.360, 18.635, 0.004, 0.055 and 0.002 ppm, respectively). The authors concluded that all water sources in Dongola and Merowe Localities are not suitable for drinking and require urgent attention by the authorities.

The sources of these HMs must be thoroughly investigated, because the nature of effects could be toxic (acute, sub-chronic or chronic), neurotoxic, carcinogenic, mutagenic or teratogenic. For example, Cd is toxic at extremely low levels. In humans, long- term exposure results in renal dysfunction, characterized by tubular proteinuria. High exposure can lead to obstructive lung disease. Cd is also associated with bone defects, viz. osteomalacia, osteoporosis and spontaneous fractures, increased blood pressure and myocardic dysfunctions. Depending on the severity of exposure, the symptoms of effects include nausea, vomiting, abdominal cramps, dyspnea and muscular weakness. Severe exposure may result in pulmonary edema and death [16-19].

A notably serious effect of Pb toxicity is its teratogenic effect. Pb poisoning also causes inhibition of the synthesis of hemoglobin; dysfunctions in the kidneys, joints and reproductive systems, cardiovascular system and acute and chronic damage to the CNS and peripheral nervous system [20,21]. Other effects include damage to the gastrointestinal tract and urinary tract resulting in bloody urine, neurological disorder and can cause severe and permanent brain damage [16,17,22,23]. Pb affects children by leading to the poor development of the grey matter of the brain, thereby, resulting in poor intelligence quotient (IQ) [24]. Acute and chronic effects of Pb result in psychosis. Zn has been reported to cause the same signs of illness as does Pb and can easily be mistakenly diagnosed as Pb-poisoning [16]. Zn is considered to be relatively non-toxic, especially if taken orally. However, excess amount can cause system dysfunctions that result in impairment of growth and reproduction [16,17,25]. The clinical signs of Zn toxicosis are vomiting, diarrhea, bloody urine, icterus (yellow mucus membrane), liver failure, kidney failure and anemia [25]. Hg has no known function in human biochemistry and physiology. Inorganic forms of Hg cause spontaneous abortion, congenital malformation and gastrointestinal tract disorders [20,21]. Arsenics toxicity symptoms depend on the chemical form ingested, as with Pb and Hg [20,26].

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Conclusion

Therefore, it is concluded that the haffirs in general, and especially those in Gedarif state must be studied in details to investigate the sources of these HMs and how to reduce their levels to avoid the expected health effects on the human and animal population of the State.

Bibliography


17. INECAR. Position Paper Against Mining in Rapu-Rapu, Published by INECAR, Ateneo de Naga University, Philippines, Institute of Environmental Conservation and Research (2000).

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