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Comprehensive Assessment of Air, Soil, and Water Pollution for Environmental Health in Al-Hai City, Iraq

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Abstract*— Sustainability has evolved into a broad phrase that includes practically every aspect of life on the Earth, from local to global, and over different periods. Sustainable biological systems include healthy, long-lived forests and wetlands. This paper aimed to study and measure pollution indicators in the Al-Hai city center's air, soil, and water in Wasit province, located at Coordinates (32.1742 N° and 46.0433 E°). The data for Al-Hai city's ambient air pollutants (CO, NO, NO_2, H_2S, SO_2, and CO_2) that considered air pollution was recorded for the date (12-13/12/2021). The Maximum values for the concentration of carbon monoxide CO and sulfur dioxide SO_2 were 1.019 ppm and 0.0321 ppm, respectively. The water and sediment samples were collected in December 2021, and all samples were analyzed in the laboratory. Heavy elements (Cd, Pb, As, and Hg) were measured in soil and water. The samples were collected and taken from two stations in the Gharraf River of Al-Hai city in Wasit province to investigate the potential for environmental damage caused by these components in this region. This study will be conducted at two stations (North and South of Al-Hai city center) beginning in December 2021. In the south station, all heavy elements showed exponential growth in water and sediment samples, but concentrations in the north station were low. The highest value recorded in this study was for the pb concentration in the soil samples taken from the main street, which was 31.9 ppm. The rates of air, water, and soil pollutants increase in the winter due to the increase in the amount of rain, which leads to the deposition of pollutants and an increase in the water level of the Gharraf River. Another reason for the presence of pollutants is the inability to manage wastewater.

***Keywords*— pollution, Sustainability, Environment, Heavy elements**

I. INTRODUCTION

Environmental pollution has increased with the use of fossil fuel energy, especially in recent decades, and there is a relationship between pollution and the economy [1, 2]. The term "environment" refers to a biosphere composed of the earth, the atmosphere, the water, and numerous creatures. The biosphere is extensive and intricate, but it is divided into several parts based on the interaction between living things and the surroundings that support them, such as the land, water, and atmosphere. Substances that disrupt, harm, or disturb the physical and biological systems in their immediate surroundings are classified as pollution [3]. Environmental issues are becoming more prevalent due to rising levels of atmospheric greenhouse gases, GHG emissions worldwide, Climate change, and environmental depletion induced by GHG emissions [4]. Pollution is any abrupt or gradual change in the environment's chemical, physical, and biological properties. When raising revenue, the government may rely heavily on pollution fines to achieve environmental goals [5]. River water pollution contains heavy elements, oils and greases, suspended solids, organic compounds, and oxygen requirements [6]. Air pollution is the release of pollutants into the atmosphere that are harmful to the environment and human health [7]. The steady stream of elements into the water from manufacturing, domestic actions, and mining has ensured that pollutant levels remain a problem. Human-caused hazardous heavy element emissions outweigh natural sources fluxes [8]. Environmental sustainability entails addressing our present demands without harming future generations' rights and abilities to meet their own. Opportunities were recognized and taken to limit waste generation and the use of dangerous materials, to avoid soil, water, and air pollution, to save and reuse resources when practicable, and to use a low-carbon economy [9]. Heavy elements are dangerous pollutants in aquatic settings because of their propensity to remain in the environment for long periods, their toxicity even at low concentrations, and their capacity to enter watery ecosystems and food chain creatures like fish [10]. Heavy elements naturally occur in the aquatic ecosystem and environment in trace concentrations and vary depending on the sediment type [11]. The distribution of heavy elements over time corresponded to human activity and environmental change. The primary source of heavy elements is the combustion of fossil fuels in transportation, factories, and laboratories; they are then transferred to the atmosphere and can be deposited in soil and water on the earth's surface. Heavy elements enter water and soil via industrial and consumer waste, sewage, or acid rain [12]. High levels of heavy elements were detected in water from wells in the studied area during the rainy months of January, February, March, and April, as well as May and June, indicating that rainwater is a significant source of pollution by heavy elements in subsurface water in Southern Iraq [13]. Discharges of chlorine or other biocides and small-volume

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discharges of sewage might have chemical impacts. Chemical spills and heavy elements leached from cooling system piping, Mercury, and other liquid wastes are among the problems with water quality that have been brought up. [14]. Most heavy elements enter the atmosphere due to volcanic eruptions, fires, and pesticide use. Heavy element adsorption occurs between the atmosphere, water, and soil. Lead enters the environment through dust deposition, rain, and fuel use in laboratories, factories, and vehicles. The central nervous system is mammals' primary mercury target (Hg). Although the effects of Mercury on wild animals, it might be challenging to see and notice behavioral changes. Mercury poisoning is most likely to appear initially as problems with coordination, disorientation, vision or hearing, and lack of coordination. Mercury poisoning may also cause mass stranding of marine mammals, though bacteria, viruses, and underwater sonar activity are frequently cited as causes of marine mammal stranding [15]. Many researchers have recommended preserving the environment by using new strategies and shifting towards using renewable energy and not burning the gas associated with crude oil production. It is essential to use effective modern technologies to control the emission of harmful gases and to conduct further studies and research on the effects of associated gas combustion on human health and the environment [16].

The goal of this study is to record and study the air pollutants (gas emission) of Al Hai city center and measure four heavy elements (Hg, Cd, Pb, and As) in the Gharraf River's water and soil near Al-Hai city in Wasit province.

II. STUDY AREA

The pollution index has been recorded in the Al-Hai city center. Moreover, two regions were chosen on the Gharraf River to execute the present research, as shown in Fig. 1, to determine how likely heavy elements would pollute the region and how far the contamination has traveled. As a result of human activity and the presence of Al-Hai Hospital near the Al-Gharraf River, the Al-Gharraf River was selected. Before and after the district, this region has been separated into two sections:

Station 1: A control station located in the Al-Hai district in the north.

Station 2: South of the Al-Hai district, the contaminated area. Abbreviations and Acronyms.

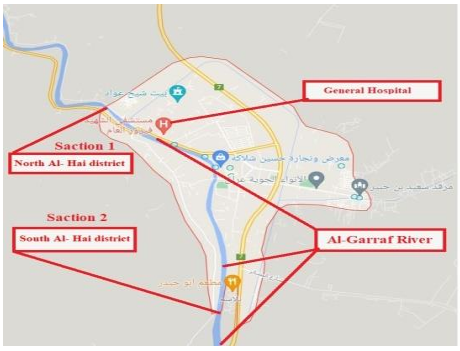

Fig. 1: The Gharraf River stations.

The data for Al-Hai city's ambient air pollutants (CO, NO, NO_2, H_2S, SO_2, and CO_2) that considered air pollution was recorded for the date (12-13/12/2021). The concentration of gases did not exceed Iraqi regulations or

III. EXPERIMENTAL PART

A. Samples Collection

Water samples were taken from two regional stations, from the river's Center and at a depth of about 30 cm below the water's surface, from the first to the second station. The samples were collected in 5-liter polyethylene plastic bottles, evaluating heavy elements and doing physical analyses with three random duplicates at each station. After A few drops of concentrated nitric acid equating to 2 ml/l, the samples were evaluated to determine their effectiveness as a stabilizer for conserving heavy elements in water. Sediment samples were taken from the Center of the river using the Van Veen Grab Sampler and stored in nylon bags labeled in a refrigerator and a cooled box [17].

B. Recorded Air Pollutants:

The dragger device (made in Germany) was used to measure and record the concentration of CO and CO_2 gases using the kit (Chip, which contains ten tests) made in Germany. The concentration recording depends on analyzer optics and specific chips. The other data on gas concentration were recorded by using other devices. The wind speed and temperature data were from the Ministry of Agriculture Iraqi Agro Meteorological Center.

C. Take heavy elements out of the water (Methodology)

All samples were analyzed in the laboratory of the Technical Institute in AL-Shatrah. The method of (Rielyt and Taylor, 1968) was used for the extraction of heavy elements [18]. The water samples that had been filtered were run through an ion exchange column measuring 50 by 2.5 cm, which had resin of the Chelexs 100 type with a sodium form size of 50–100 ml. The resin was washed after adding 10 ml of deionized water and 50 ml of nitric acid (2M) to the column. The distillate was then collected and put in a 50 cc plastic beaker. The Evaporator Vacuum was the elute. After rinsing the residue until it was almost dry (2 milliliters), 1 milliliter of nitric acid and 25 milliliters of deionized water were added. After that, samples were put into 25 ml plastic bottles to be prepared for the PGAA500 atomic absorption spectrophotometer's later examination of the heavy elements. [18].

D. Take heavy elements out of the soil (Methodology):

Although there are other ways to extract heavy metals from sediments, the approach outlined by (Yi et al. 2007) [19]. Was chosen for this study since it is widely used in Iraq and the necessary materials were readily available. After gathering and drying the sample, 1g was put inside a Teflon beaker. This procedure made use of baroclinic, nitric, and hydrochloric acids. After that, the material was filtered and put into pristine 25 ml plastic bottles to be measured using atomic absorption spectrometry [19].

IV. RESULTS AND DISCUSSION

A. Ambient Air Pollutant:

US EPA standards for air quality. The maximum value of CO concentration was 1.019 ppm at 20:01 on 12 December 2021, because of congestion and many cars. Wind direction and speed affected the dispersion of the pollutant. The minimum value of NO_2 was 0.0024 ppm. Other results of Air pollution are shown in Table 1.

Table (1): Recorded data for ambient air pollutants of Al-Hai city center.

Date	Time	SO_2 Ppm	NO_2 ppm	CO_2 ppm	NO ppm	CO ppm	H_2S ppm	Wind speed m/s	Temperature C°
12/12/2021	13:00	0.0257	0.0067	345.6	0.0519	0.2150	0.0163		
12/12/2021	14:00	0.0309	0.0070	354.2	0.0026	0.1931	0.0071		
12/12/2021	15:00	0.0321	0.0033	347.1	0.0013	0.1950	0.0077		
12/12/2021	16:00	0.0306	0.0024	344.2	0.0011	0.1897	0.0079		
12/12/2021	17:00	0.0279	0.0043	346.1	0.0013	0.2088	0.0064		
12/12/2021	18:00	0.0243	0.0099	348.3	0.0012	0.3170	0.0046	Ave=1.69	Ave=13.29
12/12/2021	19:00	0.0214	0.0273	356.4	0.0040	0.5817	0.0047	Max=6.41	Min=7.02
12/12/2021	20:00	0.0189	0.0265	367.3	0.0070	1.019	0.0055		Max=19.56
12/12/2021	21:00	0.0165	0.0344	378.5	0.0188	0.9657	0.0054		
12/12/2021	22:00	0.0149	0.0336	379.9	0.0185	0.8190	0.0038		
12/12/2021	23:00	0.0121	0.0233	376.9	0.0665	0.7963	0.0185		
Average		0.0232	0.0162	358.59	0.0158	0.5000	0.0079		
13/12/2021	00:00	0.0115	0.0199	375.3	0.0044	0.5404	0.0127		
13/12/2021	01:00	0.012	0.0248	376.8	0.0030	0.4604	0.0108		Ave=13.59
13/12/2021	06:00	0.0076	0.0056	356.1	0.0012	0.1867	0.0103	Ave=2.07	Min=7.71
13/12/2021	07:00	0.0070	0.0078	357.3	0.0011	0.2068	0.0056	Max=7.78	Max=19.47
13/12/2021	08:00	0.0063	0.0140	363.2	0.0054	0. 436	0.0046		
13/12/2021	09:00	0.0083	0.0231	379.9	0.0095	0.7331	0.0057		
Average		0.0087	0.0158	368.1	0.3374	0.4254	0.0082		

B. Heavy Elements in Water Samples :

Fast population development and increased human municipal, industrial, and agricultural activities have led to a loss of ecosystem balance. The result shows the maximum value was (16 µg /L) for the Pb element in the second station, and the minimum value was (0.0003 µg /L) for the Hg element in the first station, as shown in Tables 2 and 3. The study and analysis of the samples for heavy elements show an increase from the second station in Al-Hai district, located south of Al-Hai city (winter 2021). Pollutant levels may have risen due to waste dumped into the river by the city or the general hospital in Al-Hai, located directly on the river's banks. The high Lead concentrations in the water (Fig. 2) could be attributed to the movement of cars and the city's high traffic density, particularly in the south and along Main Street. The effects of increasing some Lead element concentrations are prevalent in vehicle exhaust.

Table (2): Heavy elements concentrations in water samples from north of Al- Hai district 2021 (µg / L).

HEs	Sample 1	Sample 2	Sample 3	Max.	Min.	average
Cd	0.165	0.17	0.172	0.172	0.165	0.169
Pb	14.3	14.9	15	15	14.3	14.7333
As	0.0111	0.0113	0.0121	0.0121	0.0111	0.0115
Hg	0.0003	0.0004	0.0005	0.0005	0.0003	0.0004

Table (3): Heavy elements concentrations in water samples from south of Al- Hai district 2021 (µg / L).

HEs	Sample 1	Sample 2	Sample 3	Max.	Min.	average
Cd	0.179	0.18	0.183	0.183	0.179	0.180666667
Pb	15.1	15.9	16	16	15.1	15.66666667
As	0.0141	0.0155	0.0156	0.0156	0.0141	0.015066667
Hg	0.0008	0.0009	0.0009	0.0009	0.0008	0.000866667

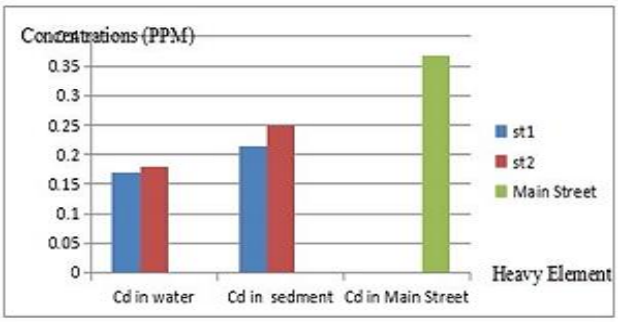

Fig. 2: The Annual rate of Cd concentration in water µg/L Sediment (mg /kg) D.W and Main Street.

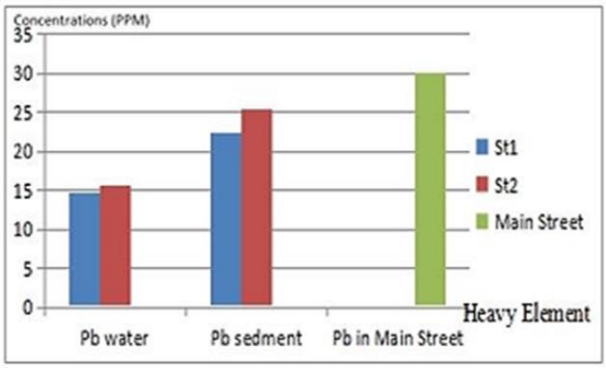

Fig.3: The Annual rate of Pb concentration in water µg/L Sediment (mg /kg) and Main Street.

C. Heavy Elements in Soil Samples:

The pollutants (Hg, Cd, Pb, and As) are stored in sediment. Recognizing the distribution and concentration of heavy elements in sediment plays an essential role in identifying pollution sources in aquatic ecosystems. Concentrations in the sediments were also higher at the second station (Tables 4 and 5) in the Al-Hai district, located south of Al-Hai. The situation is comparable to that of water. Heavy element concentrations were higher at Station 2 than at Station 1 in this study (Figures 4 and 5), corresponding to the HEs concentration in water (Figures 2 and 3). the reason may be to return to Station 2, located south of Al-Hai, indicating the impact of pollutants from the city and the associated industrial and human activity on increasing the concentrations of these elements, or perhaps due to the density of the traffic of wheels and vehicles in that station, or to the sewage waste's release without special treatment from the hospital and drainage of rainwater to the river, could be affected by the increase of these values or pollutants, this is consistent with the results of a study.

Table (4): Heavy elements concentrations in sediment samples from north of Al- Hai district 2021 (mg /kg) D.W.

HEs	Sample1	Sample2	Sample3	Max.	Min.	average
Cd	0.2	0.211	0.23	0.23	0.2	0.213666667
Pb	21.9	22.4	22.8	22.8	21.9	22.36666667
As	0.017	0.0178	0.0181	0.0181	0.017	0.017633333
Hg	0.0015	0.0017	0.0018	0.0018	0.0015	0.001666667

Table (5): Heavy elements concentrations in sediment samples from south of Al- Hai district 2021 (mg /kg) D.W.

HEs	Sample1	Sampl2	Sample3	Max.	Min.	average
Cd	0.221	0.254	0.272	0.272	0.221	0.249
Pb	24.4	25.9	26.1	26.1	24.4	25.46666667
As	0.023	0.022	0.024	0.024	0.022	0.023
Hg	0.0031	0.0037	0.004	0.004	0.0031	0.0036

Table (6): Heavy elements concentrations in soil samples from Main Street of Al-Hai district 2021 (mg /kg) D.W.

HEs	Sample 1	Sample 2	Sample 3	Max.	Min.	average
Cd	0.366	0.363	0.371	0.371	0.363	0.366666667
Pb	28.1	30.4	31.9	31.9	28.1	30.13333333
As	0.04	0.043	0.044	0.044	0.04	0.042333333
Hg	0.008	0.0098	0.01	0.01	0.008	0.009266667

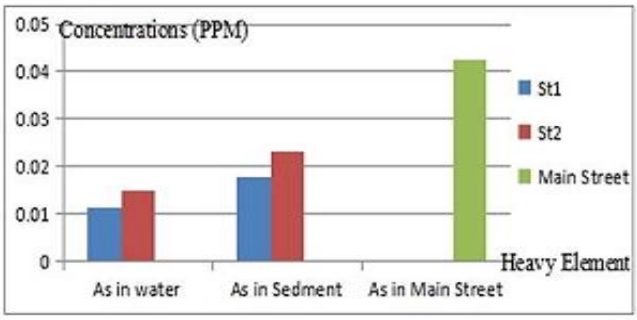

Fig. 4: The Annual rate of As concentration in water µg/L, Sediment (mg /kg) D.W and main street.

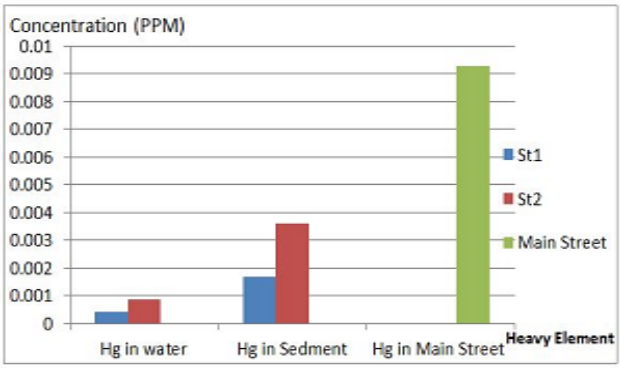

Fig. 5: The Annual rate of Hg concentration in water µg /L. Sediment (mg /kg) D.W and main street.

V. CONCLUSIONS

The health effects of environmental pollution make it a critical concern for a sustainable ecosystem. The concentration of gases in the polluted ambient air did not exceed the Iraqi regulation or the US EPA air quality standard. The results show that all heavy element concentrations were higher in the main street than in station one and station two in the sediment samples and lower in the water. The first station had a lower value than the second (south of the Al-Hai district). Compared to other heavy element concentrations, the annual rate of Hg concentration in water (µg/L), sediment (mg/kg), D.W, and the main street was lower. This study discovered higher Pb element concentration values in soil samples from the Main Street.

CONFLICT OF INTEREST

Authors declare that they have no conflict of interest

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