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Investigation of the impacts of the industrial effluent on sheep ecology downward Kwashe industrial area, Iraq Kurdistan Region

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***Abstract*---**The present study aimed to investigate the impact of Kwashe Industrial Area (KIA) in Iraqi Kurdistan Region on sheep ecology. KIA contains around 220 industrial factories, from which are more than 50 private crude oil refineries. Each day, these factories release thousands of hazardous untreated industrial effluents and create two main drains that join together and descend both Sulaivany and Duban plains that are mainly used for wheat cultivation and sheep forging to reach Mosul dam. The study is well documented and spotted a great impact on 15000 sheep habitat and niche. The sacristy of water resources in this plain, particularly in summer forces sheep to drink this hazardous effluent to be transferred through food chain to human being, and many direct health cases are investigated in this study. Annually, ten of sheep were stunned in the heavy asphalt and dies. Emissions of a variety NO_x, SO_x, CO_2, CO, H_2S, and many other volatile organic compounds like methane causes the spread of respiratory illness among the sheep in this area. Majority of the children in the surrounding villages have developed asthma and respiratory illnesses. Reproduction rate of sheep is also affected by effluents and the abortion during their pregnant period and about 50-60 sheep miscarriages in a year. A seizure is another common disease among sheep in this are as a synchronized neuronal activity in the brain is affected by pollutants in drinker effluents. The sheep around KIA have inflammation in eyes and have poor eyesight and blindness. Our investigation spotted approximately 35 sheep with eyes problems just in one village. Consequently, high numbers of sheep are died

monthly in KIA every year and the cases of sudden death among sheep are common.

***Keywords*---**food chain, habitat, pollution, sheep diseases.

Introduction

Water is used in industries as a part of products, coolant, or cleaners. Therefore, it is contaminated by various organic and inorganic pollutants. Afterwards, water surpluses are released to the environment as industrial effluents. Industrial effluents coming from different industrial and commercial establishments posing serious threats to the environment, particularly in urban and semi-urban areas and become the source of pollution for the surface and subsurface water, soil and air [1]. The management of industrial wastewater is one of the most significant concerns nowadays, this is due to the growing population density, industrialization, and highly urbanized cultures [2]. In addition, the discharge of heavy metals into the environment has exacerbated water pollution as a result of rapid urbanization and industry [3]. The nature and amounts of industrial wastewater effluents emitted differently by industry and are based on average use of daily product and water [4]. The main effluents that discharged from KIA are from private oil refineries, which work insufficiently and release a variety of huge crude oil fractions from light ones as volatile organic pollutants to heavy ones like asphalt and many other sorts of oil products and deposited across the two main drains in Sulaivany and Duban plains in Iraqi Kurdistan Region**.** [5] reported that the effects of KIA industrial effluents have reached to the ground water in some villages down ward this area and nitrate ion was elevated over 50 ppm in three villages. The petroleum refinery effluent, containing a wide range of aliphatic and aromatic organic compounds [6]. These compounds are generally considered as major source of hazardous, due to their strong toxicity, persistence, bioaccumulation and tendency to persist in the atmosphere for a long period of time; they are actually carcinogenic that harm to the environment and human health [7].

A study by [8] reported that the Petroleum refineries are the main cause of air pollution because they contain huge amounts of hazardous and toxic pollutants such as BTEX compounds (benzene, toluene, ethylbenzene, and xylene). They also contain particulate matter (PM), nitrogen oxides (NOx), carbon monoxide (CO), hydrogen sulfide (H_2S), and sulfur dioxide (SO_2). Moreover, they release some hydrocarbons such as natural gas (methane) and other light volatile fuels and oils which are less toxic. Furthermore, [9] discovered that the major gases that release from petroleum refineries are CO, SO_2, hydrocarbon compounds, suspended matter and NOx, in which they are about 98% of the total gaseous pollutants. In addition, solid waste is regarded as one of the least waste oil refineries that discharged into the environment and normally consist of asphalt and wax. Afterwards, this waste is generally disposed across the production units [8].

Based on the above information, rapid industrialization and globalization have resulted in environmental degradation, increasing a better knowledge of the

correlation between pollution, public health, and the environment [10]. The use of sewage sludge and others industrial effluents on soils is becoming increasingly popular, this has been a common practice in urban and industrial waste disposal programs, with significant environmental and recreational consequences [8, 11, 12]. Pollutants in the environment can harm animal health and reproduction by affecting a variety of organs and systems both directly or indirectly [13]. Animals typically ruminants can be exposed to the pollutants by ingestion of food and water, inhalation, and absorption through the skin, it is commonly known that in such animals, the principal route of exposure is through the diet [14]. Several of papers have been reviewed to overview the impact of pollutant in animals such as [15-17]. Therefore, the aim of this screening research is to provide a general investigation of Kwashe Industrial effluents impacts on sheep ecology as well as public health.

Description of study area

Kwashe Industrial Area (KIA) is located in the district of Summel, which is about 25 km Northwest of Duhok province, Kurdistan Region of Iraq. Kwashe industrial zone covers around 6 million m^2 at national grid reference (36°59'04.2"N 42°47'50.8"E**)** [18]. The KIA contains nearly about 220 industrial factories that release hazardous effluents such as; plastic, paper and printing, steel, leather tanning, paint, food, detergent, fertilizer, construction, nylons, metals, foam, asphalt, liquid gas plant, material recovery facility, petroleum product ...etc. as illustrated in table (1). These industries discharge approximately one million letter of untreated effluent each day as shown in (Fig. 1).

Table (1): KIA-based number & types of factories (permitted only)

Factories	NO.
Oil refineries	40
Food factories (flour meal)	5
Steel industry (steel and BRC production)	5
Aluminum and sandwich panel production	7
Paint factories	2
Fertilizer	1
Batteries acid production manufacture	1
Copper production	1
Tail and construction material	7
Oxygen and liquid gas supplier	4
Asphalt factories	4
Car oil factories	2
Electricity generation	1
Rock demolition factories	4
Nylon industry	4
Block and volcanic bricks for	7

construction	
Concert pipe	2
Plastic pipe	4
carton printing	2
Leather manufacture	2
Ironsmith manufacture	1
Detergent	4
Ceiling gypsum board	1
Metal pipes	1
Material recovery facility	1
Petroleum product storage	5
Coal production	1
Foam production	1
Cork and decoration manufacture	3
Building material	2

Moreover, the KIA involves more than fifty private crude oil refineries, which do not work according to the standard measurements and release huge amounts of non-treated petroleum effluents that contain hundreds of petrol derivatives, high concentration of heavy metals and organic pollutants (Fig. 2). In addition to the environmental factories-problematic aspect, a huge landfill is located nearby the Kwashe village, and about-800 to 1000 tons of domestic and industrial wastes are daily processed in this landfill. All above discharged chemicals and produced wastes contaminate both water and soil and emits greenhouse gasses such as methane and hydrogen sulfide [19]. Massive amounts of industrial effluents from Kwashe oil refineries are released downwards to the two main plains of Sulaivany and Duban, which are cultivated by the wheat in winter and spring and used for foraging in summer and autumn. Three channels are created by the industrial effluents and go down till international highway of Zakho-Turkey. Two of the three channels create one main drain to reach the Mosul dam far 25 Km and pollute water bodies too. Tens of villages have been effect by these effluent such as (Kwashe, Muqble, Marina, Batil, Basitke ,Geerrash, Gerdir, Malhasa, Meserik, Saidzaer, Greegawer…etc.) on the both sides of this drain that covers the main grazing area are mostly sheep breeder and they grazing their sheep in this area as shown in (Fig 1).

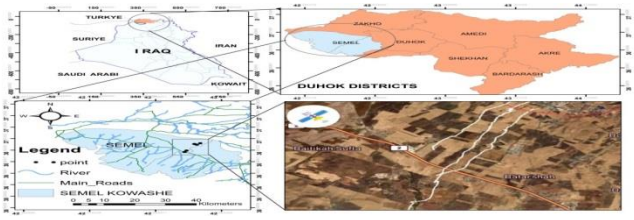

Figure 1: A. Location of Kwashe industrial area. B. Industrial effluents pathway in (KIA) across Sulaivany and Duban plains.

Figure 2: Industrial Effluents mainly from oil refineries in (KIA) and its contact with the sheep alone Sulaivany and Duban plains

Many small channels of industrial effluent are coming from Kwashe and others are derived from main channels to create more contaminated sites. These channels are considered to be the most hazardous place for wildlife and the grazing sheep in this area which they drink effluent-contaminated water. Sheep around KIA are depend in these effluents as a source of drinking water and these contaminants are accumulated in the tissues and milk which pass to human being through food chain (Figure 3).

The number of sheep in these villages across the main effluent drain is around 1000 sheep in each village, so the total numbers of sheep that have impacted by these polluted environments are more than 15000 sheep. Constituently, three villages have directly affected by effluents and tremendously disrupt the sheep ecology in this area. Beside the daily discharge of millions liters of hazardous industrial area effluent, the factories in KIA are emitting daily tremendous amounts of air pollutants mainly from oil refineries and a station of generating about 80 KV of electricity generated by crude oil downward these factories, therefore emitting a variety NO_x,SO_x,CO_2,CO,H_2S and many other volatile organic compounds like Methane and even NASA reported that this area is one of the most hazardous places for NO_x emissions as shown in figure 4. These emissions directly affect the health of this area dwellers and animals, and indirectly by depositing in the forge and diet of sheep with dust and particulate matter.

Figure 3: Sheep grazed and drink across industrial effluents drains in Kwashe industrial area.

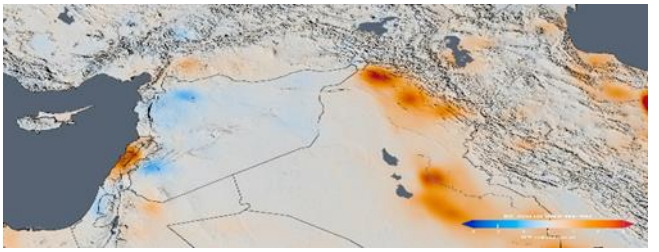

Figure (4): New NASA satellite maps show human fingerprint on global air-quality and KIA in upper northern part of Iraq.
https://www.google.com/imgres?imgurl=https%3A%2F%2Fwww.nasa.gov%2Fsites%2Fdefault%2Ffiles%2Fthumbnails%2Fimage%2F15-233-middle-east.jpg&imgrefurl=https%3A%2F%2Fwww.nasa.gov%2Fpress-release%2Fnew-nasa-satellite-maps-show-human-fingerprint-on-global-air-quality&tbnid=fcfHoL92QZxFjM&vet=1&docid=5JMS_T18LSPnMM&w=3840&h=2160&itg=1&hl=ar-AE&source=sh%2Fx%2Fi

Impacts of Industrial effluents on Sheep Ecology

Asphalt impacts on sheep

Asphalt is a one of the main products of factories that is considered to be waste and distributed by factories over the habitat and over the sheep means of walking acquiring food where they are trapped in the waste and become immobile lowering their means of survival resulting in their death (Fig. 5). Many Shepard and sheep owners were claimed that tens of their sheep keep sticking in the heavy asphalts and die [20], documented also that wide area surrounding oil refineries in KIA has been polluted by heavy crude oil and asphalt that negatively impacts living organisms in this area.

Figure 5: Asphalt in (KIA) that sheep stunned on it.

Impacts in Inhabitant

In fact, villagers have found it very hard to deal with the factory pungent strong smell emits particularly in the summer. The majority of the children in the surrounding villages have developed asthma and respiratory illness as a result of this effluent and emissions of these factories. Inhabitants from these villages keep complaining from dangerous effects of the factories' untreated discharges on their animals; as the villagers continuously lose their sheep due to these contaminated environments what directly affects the village's economy via the rapid and extreme loss of resources. Moreover, contaminating the area in ways such as lack of reproduction, seizures, blindness, and compromising their *Lactobacillus helveticas* making the sheep's milk unusable and dangerous for consumption.

Respiratory disease in sheep

Particulate matter (PM) and gases are discharged into the atmosphere primarily by factories, motor vehicles, and thermoelectric power plants, as well as biomass and fossil fuel combustion [21]. The major pollutants that discharged into the air of the (KIA) are nitrogen oxides (NO_2 or NOx), volatile organic compounds (VOCs), (CO), and (SO_2). Moreover, ozone (O_3), formed by the photo-oxidation-induced chemical reaction of VOCs and NO_2 in the presence of ultraviolet rays from sunlight which causes air pollution in specific area. High levels of oxidants and pro-oxidants in pollutants like PM of various sizes and compositions, as well as gases like O_3 and NO_2, result in the creation of oxygen and nitrogen free radicals, which – in turn – cause oxidative stress in the lungs leading to subclinical respiratory system inflammation [22]. Therefore the sheep around this area are suffered from respiratory illness and pneumonia due to this contaminant as I found about 20-25 sheep have respiratory inflammation in this industrial zone in winter 2021. Because huge amounts of toxic and hazardous gasses as mentioned above are emitted daily to the surrounding villages around KIA. In addition, many commercial chemicals and environmental pollutants, such as heavy metals and pesticides, are currently in use in KIA that directly affects the sheep. The particles stay in the environment as aerosol, fibers, fumes, mists, or dust that significantly affects sheep hygiene. Thereafter, and depended on the inhaled substance environmental pollutants might cause acute or chronic disease. Pollutants deposit on the alveolar surface, causing inflammation or fibrosis, as well as the creation of temporary or permanent tissue manifestations [23]. Moreover, the lungs act as a common interface between the animal body and the surrounding air environment. As a result, airborne contaminants are frequently deposited in the lungs [24]. Respiratory illnesses are the most common disease in sheep. Although a variety of pathogenic microbes have been linked to the development of respiratory disease, the role of environmental factors in disease development and progression cannot be emphasized [25]. The respiratory system of sheep comes into contact with about 7-8 liters of air per minute, which means, 11,000 liters of air per a day. As a result, the quality of inhaled air has a significant impact on the respiratory health of the sheep [26].

The investigation was carried out by [27, 28] indicated that the Pneumonia in small ruminants is most common in lambs aged 3–12 months, when maternal antibodies have worn out. Pneumonia can affect individual or groups and is frequently caused by a dangerous combination of pathogenic bacteria and environmental factors. Furthermore, several studies were illustrated that the main cause of acute bronchiolitis, emphysema, and right-sided heart failure in sheep was most likely due to a high quantity of sulphur dioxide in the air of industrial zone [29].

Reproduction

A wide range of anthropogenic pollutants are dispersed throughout (KIA) which are exposed to animals at low concentrations can negatively impact on animal reproduction at KIA. Almost, all animals especially sheep in KIA are subjected to abortion during their pregnant period due to these industrial contaminant. As villager complain there were about 50-60 sheep that had miscarriages in a year or

so. Inhabitants seem to think the wastewater is causing these issues, of course being used for soil to grow plants that sheep eat. Many of the reproductive disorders in sheep have been linked to a chemical in the environment are clearly established [30]. Animals are exposed to a variety of environmental contaminants through air, water, food and skin contact. Many of these contaminants have the potential to disrupt normal physiological functioning, depending on a number of factors, such as concentration of pollutant in environment , rate of uptake, and individual assimilation [14].

Industrial effluent contains a high concentration of a variety of pollutants, including organic and inorganic pollutant, heavy metals derived, etc... It is sometimes remain in land or pasture and increases in the concentrations of contaminate in soil and plant tissues, as well as animal tissues, it demonstrates that the maximize ewe exposure to a mixture of chemicals present to environmental contaminant through grazing because the contaminants were applied to the surface of the soil or herbage which animals are grazed [14].

The basic mechanisms of action of pollutants impact reproductive system have previously been explored and discussed [31, 32]. The majorities of sheep studies have focused on the effects of endocrine disrupting compounds (EDC) on the reproductive axis; have investigated the physiological consequences of EDC exposure using the standard model, which involves administering relatively large quantities of selected contaminants for short periods of time [33-35] . While, new findings from a study of the consequences of sustained, low-level exposure to EDC combinations in sheep kept on sewage sludge-treated pastures are now being released [14, 36-39].

The ovary, testis, hypothalamus, pituitary gland, and bone are all affected by pollution exposure in sheep. Changes in organ weight and gross structure, histology, and gene and protein expression have been reported as impacts of exposure [13]. Studies in ruminant have been shown to have significant impacts of exposure to chemical with recognized endocrine disrupting properties, such as octylphenol [34, 35], bisphenol A [40, 41](, methoxyclor [41], PCB153[42, 43], valproate [44], on the hypothalmicpituitary (HP) gland axis. In addition, Polychlorinated biphenyls (PCBs) have been proven to interfere with endocrine and reproductive systems in both animal and human[45, 46]. PCB exposure has been linked to alterations in hormone levels and reproductive function in animals [47, 48].

Seizure in sheep

A seizure is described as a brief occurrence of bodily indications that begin and end abruptly and are triggered by abnormally excessive or synchronized neuronal activity in the brain. Muscle contractions during a seizure episode in ruminants might lead the animal to fall down [49]. The sheep around KIA are suffered from seizure; and many cases of sheep seizure are occurred daily in villages around KIA as show in (Fig. 6) and cases of tumor development in sheep is also notices as in (Fig.7). Some authors suggested that chemical and plant poisonings are the main neurological diseases in sheep such as seizures [15, 17]. In addition, the majority of causes of seizures in both goats and sheep were caused by metabolic

issues such as lead poisoning or a high sulfur diet [50]. Furthermore, toxicity caused by copper leading to intravascular hemolysis which causes hypoxia in the tissues and spongy degeneration of the pons and brainstem resulting in seizure activity [51].

Figure 6: seizer in sheep at KIA

Figure 7: Sheep developed a tumor as it affected by effluent

Figure 8: Eye inflammation in sheep at KIA.

Blindness in Sheep

Pink eye and blindness in sheep are highly prevalent illness in sheep that causes acute inflammation in one or both eyes. Eye disease in sheep can be extremely painful or cause permanent blindness [52]. The sheep around KIA have inflammation in eyes and have poor eyesight and blindness. Our investigation spotted approximately 35 sheep have eyes problem just in one village as shown in (Fig. 8). Air pollution can impact the eye, causing redness, irritation, watering, a foreign body sensation, and vision blurring; mechanisms causing ocular surface disease involve toxicity, oxidative stress, and inflammation [53, 54]. According to the World Health Organization, air pollution contains many contaminants including PM, ozone, CO, NO_2 and SO_2. Therefore, air Pollution is widespread and

difficult to manage which lead to numerous obstacles in measuring the impact of air pollution on the eyes [55]. Investigation has attempted to discover the effects of environmental on the ocular surface, reported that kerosene, which has the potential to be a very polluting fuel, depending on whether and how kerosene combustion products affect the eye [56]. According to one study, a significant number of people who travel often through polluted locations experience subclinical ocular surface alterations [57]. Another study discovered that air pollution causes cell damage and ocular surface inflammation, resulting in eye pain [58].

Animal Death

In the industrial area animal are impacted by the contaminants because of the immediate or chronic toxicity of these compounds or the products of their decomposition, the impact of these effluents on living beings may be hazardous. High numbers of sheep are died monthly in KIA according to the inhabitant in that area every year and the cases of sudden death among sheep are common as shown in (Fig. 9). A number of papers have reviewed specific impact of metal and chemical toxicology in animals. A substantial number of grazing sheep on farmland died due to heavy metal toxicities, emaciation, anemia, anorexia, depression and weakness were observed in all of the affected sheep [59].

Figure 9: sheep die in KIA

Recommendations

Relaying on the aforementioned data, the KIA form a great threat to the surrounding environment especially of the sheep habitat and niche. The study recommends finding a fast solution to the drains of industrial effluents that flows in the downward plains and directly impacts the sheep life. These solutions come in many manners, First establishing stations of treating the various industrial effluents by the owner of factories to minimize the discharge of untreated effluents.

Ethical Approval and Consent to Participate. All procedure performed were in accordance to the ethical standard of our college research committee and with 1964 Helsinki declaration and its later amendments. Consent to Publish. Not applicable

Authors Contributions

Mustafa I. Umer conceived of the presented idea and planned the experiments, encourage to investigate the study area and supervised the findings of this work. Ronak A. Meshabaz developed the theory and performed the computations, wrote the manuscript with support from Mustafa I. Umer and Both authors discussed the results and contributed to the final manuscript.

Competing Interests

The authors declare that they have no conflicts of interest.

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Availability of data and materials

The datasets collected during this study are available from corresponding authors on request, corresponding authors had full access to the full data in study and takes responsibility for the integrity of the data and its accuracy.

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