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Assessment and management of heavy metals pollution in Tabuk region Saudi Arabia, improvement for future development: A review

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Abstract

Tabuk region is situated in the northwestern side of the Kingdom of Saudi Arabia; its strategic location is a main center connecting the three old continents, Europe, Africa, and Asia, making it one of the most promising and suitable region for industrial investment in mining industries, agriculture, fisheries, livestock, crafts, and tourism.

The importance of this region and its futuristic growth stands as a promising source for development and investment in this region, in order to achieve the VISION 2030 of Kingdom of Saudi Arabia. Giga projects like Red Sea Project, NEOM, & Line are under development, and projects will flourish greatly in this region in a way that suits the expected growth of the kingdom's economy and population. This is a preliminary review about the published data, discussing the important aspects of Tabuk region in light of heavy metals and its toxicity in ground water and marine organism. It further interprets the importance and the value of coastal ecosystems in Tabuk region. While the gaps in data and results regarding metal pollution resulting from all major activities in multiple sectors (desalination plants, industrial plants and oil refineries) in the Tabuk region, a modest redefinition of the priorities of the existing processes would be required. Recommendations, temporal monitoring and regional strategies are provided to increasingly promote the effectiveness and competence of coastal region administration.

Keywords: Heavy metals; Tabuk region; water contamination; soil.

1. Introduction

Socio-economic development combined with population growth leads to increased water needs which results in the too much usage of water resources and in producing and discharging a large volume of wastewater into receiving environments.

Indeed, in Saudi Arabia the country's development rate has accelerated and various anthropogenic activities have taken hold in several regions and areas near the large cities and also in the countryside. The pace of urbanization has increased markedly with the emergence of several urban centers and villages to the detriment of natural spaces and landscapes.

Heavy metals are considered a major anthropogenic contaminant in coastal and marine environments worldwide [1]. In toxicology, these heavy metals can be defined as metals with a cumulative character (often in biological tissues) having essentially very harmful effects on organisms living. In nutrition and agronomy, they can even be assimilated to trace elements essential to certain organisms, in particular by their catalytic action at the level of metabolism [2]. In environmental sciences, heavy metals associated with the concepts of pollution and of toxicity are generally: arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), mercury (Hg), manganese (Mn), nickel (Ni), lead (Pb), tin (Sn), zinc (Zn). Today the poor management of industrial sites results in public health problems and regional planning. However, lighter elements such as iron and aluminum commonly used in the treatment of desalination water also tend to affect living organisms, and therefore, they can have adverse effects on the environment (marine) like heavy metals. For better management of marine resources in the TABUK region, it is better to talk about metal pollution than pollution by heavy metals.

The objectives of this review are to collects general data on the origin and impact of heavy metals into soil, ground water and coastal ecosystems in Tabuk region and to identify major anthropogenic impacts. The review closes by highlighting integrated approach for improving management in Tabuk region.

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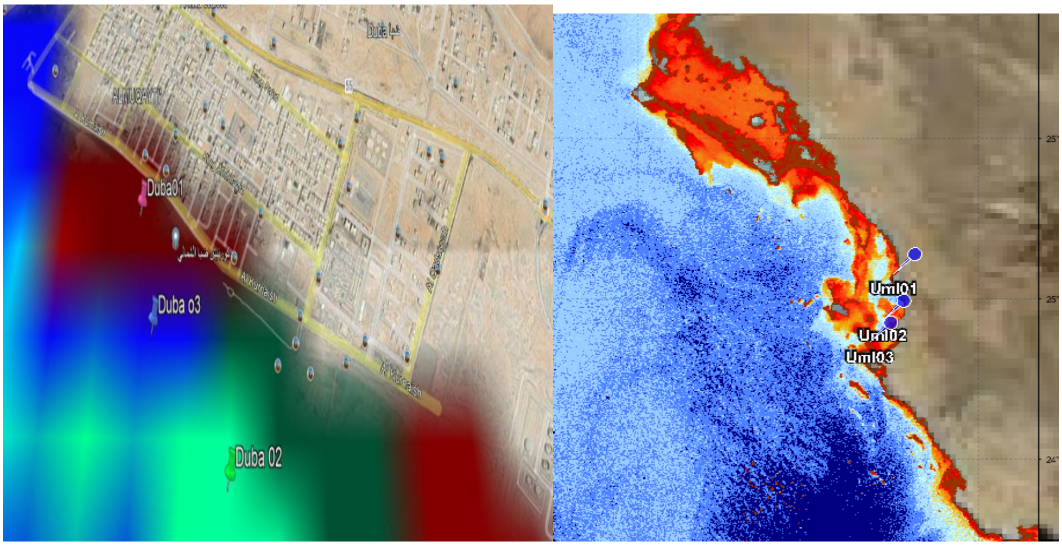
1.1 Study area

Tabuk region is situated in the northwestern side of the Kingdom of Saudi Arabia at 36o34`17" E and 28o23`59" N. It covers an area of 116.400 km^2 of land stretching on the Red Sea coast, 100 km from the south of Jordanian border to the south of the city of Umluj, and 130 km east of the Gulf of Aqaba [3].

Tabuk is the capital city of the Tabuk region and is the chief city in the northwestern side of the kingdom. It includes 71 administrative districts and 170 villages. It is divided into following six governorates; Duba Governorate (180 km from the city), Al-Wajh Governorate (350 km from the city), Umluj Governorate (520 km away from the city), Haql Governorate (200 km away from the city), Tayma governorate (225 km from Tabuk city). The first five are located along the shoreline [4].



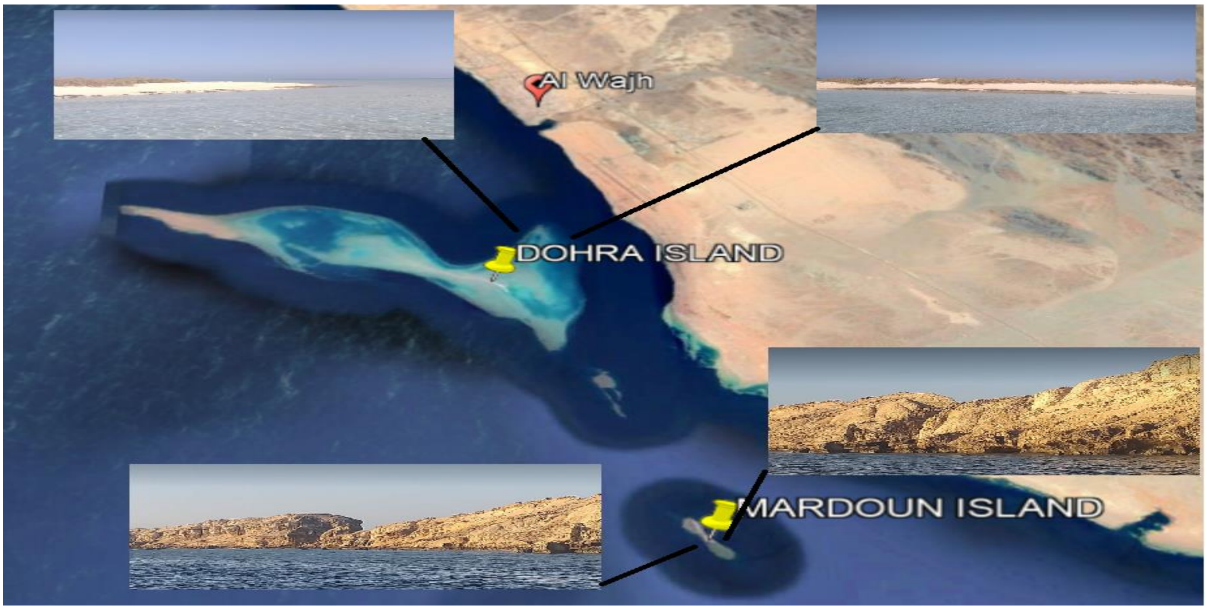


Fig. 1. Map of Tabuk region showing majors coasts and islands [4]

1.2 The importance of Tabuk region

Tabuk is one of the important city of the KSA and serve as a focal point for many of the major mega projects to meet the Kingdom's Vision 2030. These magnificent projects are the NEOM City and the Red Sea Projects. The presence of these mega-projects of national and international levels would results in significant changes in its recognition at various scales.

NEOM is the first independent special zone in the world, spanning three countries: Saudi Arabia, Jordan, and Egypt with an entire area of around 26,500 km^2 [5,6]. The NEOM Project focuses on the futures of nine specialized sectors, which are energy and water, mobility, biotechnologies, food, technical and digital sciences, advanced manufacturing, media and media production, entertainment and living.

The Red Sea Project is located between Umluj and Al-Wajh on Saudi Arabia's Northwestern coast. This project is promoted as a distinctive and luxury tourism area that will incorporate nature, culture, and adventure and will put new standards for the sustainable development and positioning Saudi Arabia as a global tourism place. It will give the entire world the chance to visit and enjoy the ecofriendly destinations.

Water pollution is a major environmental problem in urban and developing areas. In cities where industrial growth is under development, pollution by toxic chemicals and heavy metals such as lead, mercury, arsenic ... released from expanding industries and mining activities is increasing. The risk of emissions of hazardous substances is significant in these areas of activity.

Monitoring for possible pollution of surface water, soil, plants and marine organisms is therefore a necessity.

1.3 Heavy Metals as Water Contaminants

Heavy metals (cadmium, lead, mercury, etc. are metals that have a density of more than 5 g / cm^3. They are found in air, water, and soil. Oil, charcoal and wood contain varying amounts of heavy metals, so their combustion can lead heavy metals and / or their compounds to end up in the air, in the ground or in precipitation water. Some metals like other elements (trace elements, for example) can be essential for organisms such as plants and animals. If a metal "not necessary" does not bother by its absence, for against its presence, even in trace amounts, can disrupt the normal course of processes metabolic. Heavy metals are toxic except for very low doses which are tolerable. The characteristics of a heavy metal affect the toxicity of this metal as well as its mobility. The majority of the published research show the harmful effects produced by heavy metals on the Human body.

The solubility of a metal has a large influence on the actual toxicity of the latter in the environment. We therefore find non-critical elements such as sodium, some very toxic but rare like barium and still others very toxic and available as lead and mercury. In fact, metals are found in the ground in different forms: ions, inorganic and organic complexes, in solution or adsorbed on organo-clay colloids (chelates). There are heavy metals which can dissolve in water (Pb, Cd, Cr, Cu, Ni, Hg and Zn), but many others form compounds that are poorly soluble in water, thus escaping. Unlike organic compounds, cannot be biologically or chemically degraded, which is why they are persistent in the environment. In fact, metal compounds can be transported over great distances and undergo transformations sometimes leading to an increased toxicity or immobilization. The permissible amounts of some of heavy metals in farmland soil is indicated in Table number 1.

Table 1: Wastewater, soils and vegetables concentration ranges and regulatory guidelines for some heavy metals. as recommended by World Health Organization (WHO), Kenya, China, United States Environmental Protection Agency (U.S. EPA), World Bank, and Central Pollution Control Board (CPCB), India. (SWQS stands for Surface Water Quality [8]

Organization /Country	**The variable whose standards were reviewed**	**Recommended limits for the studied heavy metals (parts per million, ppm)**					
		Mercury (Hg)	**Cadmium (Cd)**	**Lead (Pb)**	**Chromium (Cr)**	**Titanium (Tl)**	**Nickle (Ni)**
World Health Organization (WHO)	Drinking water	0.006	0.005	0.01	0.1	NG	0.07
	Wastewater (effluents)	0.001	0.003	0.01	0.05	NG	0.02
	Soils (for agriculture)	–0.08	0.003	0.1	0.1	NG	0.05
	Plants (Vegetables)	0.1	0.02	0.1-0.3	1.3	NG	10
China (Chinese Ministry of Health; and The National Standards)	Drinking water	0.0001	0.005	0.01	0.05	0.0001	0.03
	Wastewater (effluents)	0.005	0.03	1.0	0.5	NG	1.0
	Soils (for agriculture)	0.3-1	0.3-0.6	80	150-300	NG	40–60
	Plants (Vegetables)	0.01	0.05-0.2	0.1-0.3	0.5-1.0	NG	1.0
National Environment Management Authority (NEMA) Kenya Bureau of Standards (KEBS)	Drinking water	0.02	0.01	0.05	NG	NG	NG
	Wastewater (effluents)	0.005	0.01	0.01	0.05	NG	0.3
	Public sewers	0.05	0.5	1.0	0.05	NG	3.0
	Soils (for agriculture)	NG	NG	NG	NG	NG	NG
	Plants (Vegetables)	0.01	0.05	0.3	NG	NG	NG
United States Environmental Protection Agency (US EPA)	Drinking Water	0.002	0.005	0.05	0.1 (total Cr)	0.013	0.02
	SWQS limit level	.002	0.009	8.5	0.08	6.3	8.3
	Water reclaimed from effluent for irrigation	NG	0.01	5.0	0.1	NG	0.2
	Wastewater (effluents)	0.00003	0.01	0.006	0.05	NG	0.2
	Soils (for a garden)	1.0	0.48	200	11	NG	72
	Plants (Vegetables)	0.015	0.2	0.3	2.3	NG	NG
World Bank	Wastewater (effluents)	0.01	0.1	0.1	0.5 (total Cr)	NG	0.5
Central Pollution Control Board (CPCB) India	Inland surface water	0.01	2.0	0.1	0.1	NG	3.0
	Public sewers	0.01	1.0	1.0	2.0	NG	3.0

Humans are exposed through inhalation of air pollutants, drinking water contaminated and exposure to contaminated soils from industrial wastes. Metals can be absorbed in the inorganic form or in the organic shape. For certain elements, like copper and arsenic, the inorganic form is the most toxic. Concerning other forms, like the organic forms are the most toxic. The elements most often encountered as phytotoxic are copper, manganese, nickel and zinc [9]. The most toxic metals to humans are cadmium, lead and mercury. The lead is a neurotoxicant, especially dangerous for children, due to their exposure more frequent; direct contact with the ground, ingestion of paint dust containing lead or exhaust gas [10]. Lead is not as toxic as cadmium or mercury, and that's probably why and for its many useful properties commercially it is the most widely used of the three. In this sense, lead presents a risk worrying for the population. Table 2 presents the major health effects highlighted for the elements considered.

Table 2. Health effects of certain heavy metals. [11]

Metals	health Effect
Arsenic	- Carcinogenic and damage to various organs (liver, nervous system, skin) - No target organs for long term exposures.
Cadmium	- High toxic potential - Kidney damage from chronic low dose exposures; - Oxides, chlorides, sulphates and cadmium are classified as carcinogens
Chromium	- Chromates damage the respiratory system for exposures long-term - Dermatological disorders, anemia; - Compounds with chromium VI responsible for eczema; Cr Carcinogenic VI (group A1: cancer proven in humans)
Copper	- Irritant effect by inhalation, allergic contact - Long-term oral damage to the liver
Mercury	- All mercury compounds are toxic at low doses; - Brain and kidney affected - Chronic intoxication responsible for irreversible damage to the central and peripheral nephew system - In the organic form may disrupt the development of the fetus
Nickel	- Allergy by contact with the skin and by presence in food for sensitive person - Nickel compounds are carcinogenic (group A1) for the nose, lung
Lead	- Causes high dose anemia - Disturbs the nervous system and kidneys - Mutagenic effect of lead acetate and phosphate (experience animal)
Vanadium	- Irritative effect in high dose on eyes, nose, bronchi
Zinc	- No carcinogenic effect of zinc by mouth or by inhalation - Zinc chromate is carcinogenic

2. Detection of Heavy Metal in Tabuk region

In recent years, the emphasis on groundwater research in developed countries has moved from issues of groundwater supplying to issues of groundwater quality. In semi-arid and arid regions the major natural processes that affect the groundwater chemistry are evaporation/crystallization produced by excessive temperatures and aquifer mineral interaction by processes such as dissolution, redox condition, precipitation, leaching, ion exchange, etc. [12, 13]. Regardless of the anthropogenic contaminants, as a result of our high consumption lifestyles, the groundwater environment is under stress by an increasing number of soluble chemicals.

While the problem of achieving acceptable surface water quality relates primarily to reducing the recognized emissions of pollutants in these systems, the problem confronting scientists and engineers in this field would be to categorize areas and mechanisms by which pollutants can enter groundwater flow systems and expand reliable predictions of the process of contaminant transport in flow systems. This identification is required as a working base to minimize the effect of occurring industrial, agricultural or municipal activities on the quality of groundwater.

Based on a Scopus and web of science database search only few studies have been conducted in Tabuk region in past years for the contamination by heavy metals. In from the monitoring and management points of view and to enhance understanding of problems related to groundwater quality in the area of Tabuk this is a not encouraging number. Table 3 indicates the results reached by the considered studies.

Table 3. Previous studies in Tabuk region

Reference	Purpose of the study	Samples	Method	Heavy metals	Results
AL-SHAMI, S. A et. al [13]	future development by Saudi government	surface sediments of Haqal coastal waters	direct aqua-regia method	Zn, Cu, Cd, Pb Ni and Fe	'Low ecological risk'
El-Sorogy et al.[14]	traffic pollution, industrial activities, and dredging of marine sediments	thirty-three surface sediments collected from Aqaba Coast	the standard methods for the examination of water and wastewater inductively coupled plasma mass	As, Sb, Hg, Ni, Cu, Cd and Pb	- For Cd potential ecological risk revealed - For Hg very high risk - Considerable risk for Cu, Sb, and As, - A moderate risk for Pb and Ni
Abeer Sh. Salman et. al [15]	Intensive agriculture and urban developments	Forty samples of water from collected from bore wells	multivariate analysis and stochastic statistics	Cu, Cr, Pb, Zn and Mn.	- Ground water quality in the study area is good and suitable for agriculture.
Nagwa S.M et. al [16]	rapid growth of population due to increasing agricultural activities around Tabuk region	Forty-eight Drinking water samples (Different localities in Tabuk)	Chemical examination using SHIMADZU atomic absorption spectrophotometer AA 6800	Hg, Pb, Cu, Cr, Cd, Ni and Mn	- Hg in 4 samples exceeded the acceptable - Se is found to be more than standard in all samples except two

2.1 Heavy metals in plant and soil

Soil stands as a support for many human activities (industrialization, urbanization, agriculture), compared to area and water, the soil is the environment that receives the largest quantities of trace elements produced by industrial activities and constitutes a receptacle place for heavy metals. Two main types of pollution anthropogenic are responsible for the increased flow of metals: pollution atmospheric (industrial discharges) and pollution linked to agricultural activities.

Compared to organic pollutants, such as hydrocarbons, for example, Heavy metals have the major drawback of not being degradable by chemical or biological processes in the soil this is referred to as the persistence of metals. They are only likely to change chemical form the distribution of which in soil is referred to as speciation and going from a compartment from the ground to another according to these transformations. If they are not present in the state metallic, they can attach to clays or organic matter by bonding ionic, or form complexes in solution, or inorganic compounds, or still attach to the surface of particles by adsorption. In this way, they accumulate into the soil, or they are washed. To describe the origin, the fate and toxicology of metals in soils, two concepts are used [18]:

- The mobility of an element characterizes its ability to move from a compartment from the ground where it is retained with a certain energy to another, where it is retained with less energy. The more a substance moves through the soil, the more it will likely be absorbed by a living organism.
- Bioavailability, which is the ability of an element to pass from a compartment any soil in a living being, (bacteria, plant, animal or man), often via the soil solution.

Metals are spread in soil in various forms. They are found in transferable shape in clays and natural substance which lets them be absorbed by the plants in the form of complexes or linked to natural molecules. They can also be incorporated in crystalline phases or adsorbed in a direct way on oxides particles or iron hydroxides, manganese, and aluminum.

Biological activities are harmfully influenced by this increase in the soil metals concentration which also decreases the nutrients availability and causes a grave danger to environment and the health of humans by incoming into the chains of food and beneath the supplies of water through the respective uptake of the plant and the leaching processes [19]. Many researchers point out that these toxic effects are closely dependent on the species considered, the route of exposure (inhalation, ingestion, skin penetration,) and exposure levels [20]. Acute toxicity is thus distinguished (strong adsorption dose over a short period of time) and chronic toxicity (low dose adsorption over time longer). It is significant to highlight that the dose or the content is for the elements only one the characteristics of its toxicity: in many cases, it is essential to know its decisive speciation for its mobility and bioavailability, this is the case, for example, of arsenic, which is much more toxic (and more soluble) in the form of As (III) than in the form of As (V) [21-22]. In their study, Huwait et al [23] reveals that different samples in Tabuk region the contains heavy metals. It is found that in surface soils, cobalt was higher than in sub-surface soil (>15 cm to up to 40 cm) in all samples. While lead and Zinc found that values were higher in sub-surface soil than in surface soil. Between surface and sub-surface soils, no difference that could be said to be significant in the levels of iron, copper, nickel and chromium existed. Vitamin B_{12} Concentrations in the liver of livestock were found to be the highest in the following order: Tabuk> Taif > Jizan> Qassim> Hail. However, the levels of liver cobalt in livestock occurred in this order: Tabuk> Qassim > Taif > Hail > Jizan.

Fifty samples were taken from agricultural farms located along the main highway roads of Tabuk [24]. Results published by Nazzal et al, suggests that Arsenic (As), Lead (Pb), Mercury (Hg) and Cadmium (Cd) are related to anthropogenic activities, while Chromium (Cr), Cobalt (Co), Zinc (Zn) and Cupper (Cu) are mostly dominated by activities that are geogenic. The concentration of Arsenic ranged from 8.10 to 33.60 ppm while Pb and Hg showed concentration as a maximum in the samples that were analyzed. As the agricultural farms are the source from which the soil samples were taken, Arsenic high values (As) may characterize the pesticides and fertilizers application in the farms. Pesticides and fertilizers use is considered the main source of Arsenic (As) in soil [25]. Mercury concentrations in the soils that were studied came to be in 1.90–3.40 ppm range. The obtained results are explained by the mining activities presence of that stands as the main sources of metals release. Indeed, rocks contacting sulfured with waters and the oxygen of the air causes rapid alteration and dissolving metals [26]. Fossil combustion fuels for operating the pumping units and oil leaks from the pumping units and the leakages from in situ oil storage tanks stands as the source of high mercury (Hg) concentration in the analyzed soils that were analyzed.

2.2 Heavy metals from effluent discharges of desalination plants

For a country with limited water resources and in full socio-economic development such as Saudi Arabia, the quantification, mobilization and rigorous management of water resources present a real challenge before considering any sustainable development strategy. In the field of desalination, Saudi Arabia has always been the first in the Middle East. To solve the problem of water shortage for residents, an increasing number of desalination plants have been spread along the country's coastline, four of them are located along the coast of the Tabuk region.

Regardless of the process used, all desalination plants produce large quantities of brine. Undeniably, researchers recognized the need to study their environmental effects on coastal marine ecosystems through studying the industrial discharges from reverse osmosis (RO) desalination plants that are marked by a high load of chemical pollutants as well as a high salinity (Fe, Cu, Ni, Zn, Cr), [27,28]. Currently, the most commonly used methods for the management of seawater desalination concentrate (brine), for limit these environmental impacts include: direct discharge into the marine environment, natural evaporation to recover salts, dilution with cooling water from power plants, dilution with discharges wastewater treatment plants and the zero liquid discharge system. Other techniques that are the pilot scale are distillation membrane vacuum (DMV), artificial evaporation and production of energy (osmotic energy).

The problem of rejections of effluents is a problem that must be treated and managed considering the speed at which the number of desalination plant increase in Saudi Arabia so the amount of rejection increases with it.

2.3 Heavy Metal in aquatic organisms

a. In fish

Heavy metals are micropollutants that has the ability to affect the marine environment safety, as they do not undertake chemical or biological degradation. Thus, they may have the capability to accumulate in in a variety of links of the trophic chains at toxic concentrations in marine life forms. However, the study of the bioaccumulation of trace metals in organisms that were subjected to them is a significant way for the assessment of toxic waste metallic. The process of bioaccumulation in an environment aquatic is very important in toxicology and may explain the long-term effects of non-biodegradable compounds, such as heavy metals on aquatic life. On the other hand, the bioaccumulation of the metal in the cells and tissues of consumers depend on their bioavailability; and the effect of toxic at the cellular level will depend on the amount penetrating but also the chemical speciation of the pollutant.

The geographical location of the Red Sea is very important, for this reason this space is a very strategic sea route for transporting people and goods especially hydrocarbons and petro-chemicals. The strong maritime transport of crude oil and products refining which represents one of the main and certainly the most worrying risks for the Red Sea, either because of the high risk of accidents causing the dumping of oily and polluting products at sea, or because of the exploitation activities of vessels such as the washing of the tanks of oil tankers. In spite of that, heavy metals' studies in the Red Sea are restricted.

Elsayed M. Younis et al [29] studied the heavy metals concentration in muscle tissues of five commercially marine fish species. Concentrations of Cr, Fe, Ni and Cd, analyzed in this study were higher while concentrations of Mn, Cu, and Pb were far below the recommended levels by various authorities (FAO/WHO, and FDA). Regional and seasonal variations of these values have been observed they are due to the overloading of industrial waste and the disposal of the water from Jeddah by the increasing of population growth, industrial activities and the tourism in the region.

The presence of heavy metals in fish, has been reported also by Wafaa Met. al. [30]. The study was carried out on 9 types of endemic fish collected from Duba coast Tabuk region. The obtained value ranged between 2.5– 25.9 (µg/g wet weight) and are generally inferiors to maximum dose recommended by the international legislation limits.

For a regional approach in Duba, Umluj and Alwajh coasts recommendations are provided to analyze the concentrations of metals in water and fish due to:

- the increasing of anthropogenic and industrial activities on the Red Sea
- the importance and economic of these regions as a significant source of fish production in Saudi Arabia
- The contribution to the development of control programs food.

b. In coral reefs

The Red Sea is recognized as a mostly thriving coral reef ecosystem, hosting some of the most productive and richest coral reef ecosystems with coral reef framework along its entire coastline [31]. Roberts et al., acknowledged the high diversity of corals reefs and their high endemism [32]. The Red sea, has also remained relatively impacted by various anthropogenic activities [33]. Local disturbances, such as desalination plants which reduce the resilience of coral reefs to global stress. In Egypt Mabrook et al. [34] reported coral mortality nearby a desalination plant. The returned hot brine, released with chemicals often have negative environmental impacts. Another greater threat are oil tankers, which may transport huge volumes of crude oil very close to coral reefs. [35]

No study has been conducted to analyze impacts of desalination plant effluents on corals reefs in Tabuk coastal and to combat exposure to toxic substances.

3. Strategies and plan for controlling heavy metals pollution in Tabuk region

Historically, researchers have been interested first in human health rather than the environment, then in the pollution of water rather than soil. Today the risks are known, and it is up to begin with the assessment and management risk and to decide because human activities potentially have negative effect and decisions must be taken. The initial approach stems must begin from research laboratories which identify the first the toxic effects due to a pollutant from field analyzes and toxicological analyzes. In the table below (Table. 4) are given the main goals, objectives and strategies to engage stakeholders across various sectors and from multiple levels of society, providing the awareness of the importance of maintaining environmental integrity process to better regulate development in Tabuk region.

Table 4. Plan for Heavy Metals Assessment Study in Tabuk region

Region	Importance	Objectives	Strategies and Activities
Tabuk governorate	-The strategic location -Wealth in natural ingredients and mineral raw resources. -one of the major agricultural center of the Kingdom and has a tremendous floristic diversity.	-To establish a working group that shall take forward the work. -To develop management plans. -To monitor ground water resources and their responses to projected climate changes.	1- To monitor the spatiotemporal variabilities in groundwater resources in Tabuk governorate 2- to measure the concentrations of heavy metals (As, Cd, Cr, Cu, Ni, Pb, and Zn) 3- To determine the physicochemical parameters (salinity, pH, oxidation reduction potential and dissolved oxygen 4- determine the sources of heavy metals 5- determine the degree of pollution in ground water 6- To study the potential ecological risk of heavy metals
Alwajh	-tourism opportunities : **Neom** and **Red sea** projects. -High marine biodiversity serves as a stockpile of potential food sources, marine natural products. -Provision of potable water by seawater desalination (desalination station in Alwajh)	-to establish a monitoring plan. -to manage natural resources facing socioeconomic development. -to develop a specific strategy to ensure the healthy use of marine resources. -to protect coral reefs when they undertake large-scale projects coastal areas. -to discuss impacts from desalination plants	1- mapping of the study area using remote sensing 2- to gather scientific data and information on both the ecosystems and activities 3- to identify major anthropogenic sources affecting ecosystem functioning 4- to investigate harmful and toxic species of microalgae spread along Alwajh coast. 5- to investigate the distribution of pollutants in the fish organs and the differences of metal concentrations in sampling.
Umluj	-rich mosaic of productive and diverse ecosystems. -beautiful marine and coastal environments. - the diversity of species inhabiting them the high degree of endemism -Development of a touristic project (red sea project) -Expansion of desalination plant	-to establish a working group that evaluate. -effectiveness of marine protected areas MPAs management. -to conserve and manage coastal marine systems.	1- monitoring the occurrence of different phytoplankton and phycocyanin species 2- study the rate of metal accumulation in marine organisms of different chemical forms: ions or molecules, organic or inorganic 3- to analyze impacts of desalination plant effluents on corals reefs
Duba	-Expansion of desalination plant.	the need to involve all stakeholders and agencies involved in the planning process.	1- monitoring of oil and chemical pollution in marine waters and coastal areas 2- to investigate the gradient of heavy metals concentration that resulted

	-Saudi Aramco **Ahmar-1 field** expansion		from oil refiners and desalination plant. 3- sampling, data analysis and reporting of metal concentrations in fish.

4. Conclusion

The infra-structure for the expansion of Giga projects all over the country has been established by a series of development plans in the Kingdom of Saudi Arabia. Tabuk region is one of the largest contributors to programs because of their sole and striking marine and coastal backgrounds, species the diversity existing in them, the endemism high degree, as well as the worth of these rich resources for human welfare and development. It is increasingly apparent to model environmental responses to anthropogenic obstacles and to develop the manner we arrange our ideas, and the way we evaluate development on the coastal level, guard marine and coastal environmental resources and run coastal and marine risks.

The research project given here provides a significant initial step in bringing stakeholders cross a variety of sectors and from numerous society levels, presenting a chance to enlarge consciousness of the significance of targeted research plans based on management. On the other hand, this help s them react to their conflicting needs for technical and scientific support in order to take part in an efficient way.

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