



هيئة البيئة
ENVIRONMENT AUTHORITY

Minamata Convention on Mercury
Initial Assessment
Report for Oman

2024



Minamata Convention on Mercury Initial Assessment Report for Oman 2024

Executive SUMMARY

Globally, the Mercury contamination has become a challenge, threatening life and the environment. It is one of the most toxic and hazardous pollutants. As a result, the United Nations, through the United Nations Environment Programme (UNEP), has launched several initiatives to address the issue at both the national and sectoral levels.

One such initiative is the Minamata Convention on Mercury. The Minamata Convention on Mercury is an international multilateral environmental agreement aiming to limit worldwide Mercury (Hg) emissions and releases, exclusively from artificial activities and sources. After a lengthy debate and discussion lasting over 15 years, the Convention became effective on 16 August 2017. As of August 2024, one hundred and forty-eight countries are parties to this Convention. The Sultanate of Oman ratified the Convention on 28 May 2020 by the Royal Decree 58/2020. The Environment Authority, Oman, is responsible for implementing the obligations under the Minamata Convention on Mercury.

The Environment Authority, Oman, went to great lengths to conduct this study on the Minamata Initial Assessment in Oman. The study started in 2022 and involved both quantitative and qualitative analyses. Several field studies were conducted, and workshops and seminars were organized. The data were collected from the relevant authorities, including the Ministry of Health, and Environment Authority. The objective was to assess the state of

Mercury release, current initiatives, and challenges the authorities are facing to handle this global issue.

The study found that Mercury is released in Oman during the extraction and use of fuels and mineral oils. The extraction of fossil fuels causes Mercury to be released into the water, provided there are no emission controls. The amount of released is 32.80 Kg Hg/y. Further, fossil fuel refining causes Mercury to be released into the air and water. The amount released to air and water is 9.10 Kg Hg/y and 0.36 Kg Hg/y, respectively, provided no emission controls exist. Moreover, using fossil fuels by vehicles causes the release of Mercury into the air (6.72 Kg Hg/y). In refining natural gas, the amount of Mercury released to the air is 0.78 under the condition of no Mercury removal. During the extraction of mineral oils, the calculated Mercury output released into water is 32.28 Kg Hg/y. While refining the mineral oils, the Mercury is released to the air (9.10 Kg Hg/y), water (0.36 Kg Hg/y), and sector-specific waste treatment (5.46 Kg Hg/y). In Oman, there are a few underdeveloped sites where mercury-contaminated products can be disposed of. Mercury is released from the disposal of manometers and gauges into air (18.98 Kg Hg/y) and water (56.93 Kg Hg/y). Additionally, the other sources are the sector-specific waste treatment (56.93 Kg Hg/y) and general waste treatment (56.93 Kg Hg/y). Similarly, Mercury is released from

the disposal of laboratory chemicals and equipment into the air (14.94 Kg Hg/y). Additionally, the other sources of Mercury released from laboratory chemicals and equipment are sector-specific waste treatment (15.39 Kg Hg/y) and general waste treatment (14.94 Kg Hg/y). However, the key Mercury is released from using other intentional products and laboratory equipment to water (59.76 Kg Mercury/y). In addition to this, other sources include the sector-specific waste treatment (61.57 Kg Hg/y) and general waste treatment (59.76 Kg Hg/y).

Moreover, the study identified significant Mercury leaks from recycled ferrous metals (iron and steel). The discharges to water, land, and general waste treatment are unique to a given industry. The Mercury is released to the water (0.33 Kg Hg/y), land (0.34 Kg Hg/y), and general waste treatment (0.33 Kg Hg/y). The incineration of medical waste releases Mercury. For instance, the Air (21.19 Kg Hg/y) and Water (21.19 Kg Hg/y). Similarly, in the case of controlled landfills/deposits, the key Mercury released to air and water are 5.84 Kg Hg/y and 0.26 Kg Hg/y, respectively. In the case of wastewater treatment, the key Mercury's is released into water, general waste treatment, and sector-specific waste treatment. The calculated output release is 225.77 Kg Hg/y, 135.46 Kg Hg/y, and

90.31 Kg Hg/y, respectively.

The outcome of this study is compiled into the form of this report. This report includes six chapters. Chapter 1 presents the national background of Oman, including social, environmental, and economic insights of the Sultanate of Oman, the impact of Mercury on the environment, and humans, with its primary sources in Oman. Chapter 2 clarifies the key Mercury releases to air (the atmosphere), water (marine and freshwater bodies, including via wastewater systems), land, general waste, and specific sectors. Chapter 3 describes the laws, regulations, and measures taken by the Environment Authority, Oman, for instance, the policies, regulations, and framework assessment on Mercury. Chapter 4 provides a comprehensive analysis of the identification of gender aspects and populations at risk. Chapter 5 details the awareness programs concentrated on essential industries and sectors, including health, labour, mining, agriculture, and non-governmental organizations. Finally, Chapter 6 outlines the priorities identified for relevant ministries and stakeholders through a series of consultations. These priorities are designed to be implemented to safeguard both the environment and the population from the harmful impacts of mercury on human health and ecosystems in Oman, culminating in a comprehensive solution presented as a National Action Plan.



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Glossary

Alphabetical list of words related to a specific subject, text, or dialect, with explanations; a brief dictionary

Abbreviations	Explanation	Abbreviations	Explanation
ASMG	Artisanal and Small-scale Gold Mining	UNEP	United Nations Environment Programme
CFL	compact fluorescent lamp	Kg/y	Kilogram per year
CNS	Central Nervous System	Kg Hg/t	Kilogram Mercury per Tonne
EA	Environment Authority	KOM	Knowledge Oasis Muscat
EIA	Environment Impact Assessment	MeHg	Methyl Mercury
EU	European Commission	mg/Kg	Milligram per Kilogram
EPA	Environment Protection Agency	MOH	Ministry of Health
EtHg	Ethyl Mercury	MOD	Ministry of Defence
GEF	Global Environmental Facility	USEPA	United States Environment Protection Agency
HS	Harmonized System	UV	Ultraviolet
Hg	Mercury	µg/Kg	Microgram per Kilogram
MEM	Ministry of Energy and Minerals	VCM	Vinyl Chloride Monomer
MIA	Mercury Initial Assessment	WHO	World Health Organization
PDO	Petroleum Development Oman		

Foreword

Posing serious local pollution issues, Mercury (Hg) can be oxidized, travel great distances through the atmosphere, and/or end up in ecosystems. Regional and distant sources of Mercury can transform into the dangerous neurotoxin methylmercury (MeHg) in aquatic systems. Methylmercury exposure at high doses can cause mortality, severe neurological impairment, and heart problems. Particularly in young children, low-dose exposure has been connected to neurological damage that disrupts brain and muscle function as well as developmental delays. Because Mercury threatens human health and the environment, it is a significant global, regional, and national concern.

Even though natural events can release Mercury into the environment, human activity is currently responsible for most of the environmental Mercury. The following economic activities are the primary sources of Mercury emissions and releases in Oman: cement production, oil and gas exploration and exploitation, gold and other mining activities, use of and improper disposal of products containing

Mercury and their wastes. The Sultanate of Oman joined the rest of the world to negotiate the Minamata Convention on Mercury, Mercury Initial Assessment (MIA), a worldwide legal agreement, in support of global measures to address the rising levels of Mercury in the environment.

Considering the importance of the Convention, the Sultanate of Oman acceded to the Convention on 23 June 2020.

To implement the Convention at the national level, the Sultanate of Oman carried out a project in 2023 called «Development of Minamata Convention Initial Assessment for Sultanate of Oman», funded by the Global Environment Facility (GEF) with assistance from the United Nations Environmental Programme (UNEP) and its Regional Office of West Asia (ROWA). The project was implemented in 2 steps. The baseline assessment, which includes the compilation of the national mercury inventory and information related to the Minamata Convention on Mercury, aims to inform national stakeholders about the Convention and its advantages for the country. This constitutes one of the main

deliverables of the project under its first phase.

The «Minamata Convention Initial Assessment» report, developed under step 2, is to help Oman facilitate policy and strategic decision-making and identify priority areas for future interventions on maritime-related issues.

The Sultanate of Oman's initial assessment report under the Minamata Convention on Mercury provides a roadmap for implementation of the Convention at the national level. Its development and adoption are a tangible example of the Sultanate of Oman's commitment to implementing the Convention's provisions. The Environment Authority (EA), the coordinating agency, is presenting this document to all of Oman's development partners for implementation and support in protecting human health and the environment from anthropogenic emissions and releases of Mercury and Mercury compounds. Our objective is a pollution-free environment. This document will significantly assist in accomplishing this goal.

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Chairman of Environment Authority
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Acknowledgment

The Minamata Convention on Mercury Initial Assessment (MIA) in the Sultanate of Oman project was implemented under the direction of the Environment Authority (EA) in close coordination with the United Nations Environment Programme (UNEP) and its Regional Office for West Asia. The project's remarkable success results from the diligent work, thorough research, devotion, and inclusive participation of numerous individuals and organizations. The Environment Authority, Oman, hereby extends its sincere gratitude to all national stakeholders who helped draft this document and to all members of the ministries who contributed. The consultant and project team members are recognized for their hard work ensuring the project runs well. Ms. Azhar Juma Al-Hinai (Environment Authority), Mr. Hassan Ali Al-Kaanuini (Environment Authority), and Dr. Sajjad Ahmad Siddiqi (Environment Authority) make up the project team. We also thank UNEP for its continuous technical assistance in producing this report. We are also highly thankful to the United Nations Environment Programme (UNEP)

and the Global Environment Facility (GEF) for providing financial support to accomplish the project and its implementation. I also want to recognize the crucial contributions made to the success of the overall MIA project by Mr. Sami Dimassi (UNEP), Mr. Abdul-Majeid Haddad (UNEP), and Iyngararasan Mylvakanam (UNEP). The Environment Authority also acknowledges the UNEP international consultant, Dr. Motasem Saidan's examination of the document during its preparation and finalization of all phases. The Environment Authority is dedicated to shielding the environment and public health from the dangers associated with Mercury. This document should be extensively distributed to all pertinent parties to facilitate the necessary measures and actions. It offers comprehensive information on Oman's Mercury management challenges to implement the best practices for future endeavours.

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Chapter 1: Introduction



1.1 National background information

1.1.1 Overview of Sultanate of Oman

The Sultanate of Oman faces the Arabian Sea, the Gulf of Oman, the Arabian Gulf, and the Strait of Hormuz. It is located on the southeastern edge of the Arabian Peninsula. Oman shares a border with Yemen, Saudi Arabia, and the United Arab Emirates. Since January 2020, His Majesty HH. Sultan Haitham bin Tarik Al Said has been the head of state of the Sultanate of Oman. Oman is governed under an absolute Arab monarchy known as a Sultanate, where the Sultan has all judicial, executive, and legislative authority. The total area of Oman is 309,500 km². Different geographic elements comprise the land area: the coastal plain makes up 3%, mountain ranges make up 15%, and valleys and deserts make up 82% of the land mass. According to Royal Decree No. 11/4/2011, issued on 26th October 2011, Oman comprises 11 governorates: Muscat, Dhofar, Musandam, Buraimi, Dakhiliyah, North Batinah, South Batinah, South Sharqiyah, North Sharqiyah, Dhahirah, and Wusta. There are significant reserves of natural gas, chromium, gypsum, marble, copper, asbestos, and petroleum. There are vast expanses of a broad plain with gravel desert dotted with wadis and enormous pools of water in the midst, and valleys between steep mountain ranges with terraced orchards where pomegranates, apricots, and roses flourish.

Oman shares borders with Saudi Arabia, Yemen, and the United Arab Emirates, measuring 676 km (420 miles), 410 km (250 miles), and 288 km (179 miles), with a coastline spanning 3,165 km (1,967 miles). Yemen is in the southwest, the Arabian Sea in the southeast, the Gulf of Oman to the north, the United Arab Emirates to the northwest, and Saudi Arabia to the west. The country is divided into six separate regions by its natural features: Ru'us al-Jibal, which includes the northern Musandam Peninsula; the Batinah plain, which stretches southeast along the coast of the Gulf of Oman. The interior of Oman behind the Batinah coast, which includes the Hajar Mountains, their foothills, and the desert's edges; the coast from Muscat to Matrah,



Map of Oman

which stretches down the Arabian Sea around the point of Ras Al Hadd; the offshore island of Masirah; and, lastly, the desolate coastline that stretches south to the Dhofar region.

The interior of Oman has a hot, dry climate, whereas the coastal area experiences hot, humid weather. In the capital of Muscat and nearby coastal areas, summer temperatures frequently reach as high as 110° F (43° C). The temperature during winter is typically around 63° F (17° C). Summertime temperatures on the Batinah coastal plain rarely rise over 47° C (116.6 °F), but humidity levels can reach up to 90% due to the low height. The temperate and pleasant winter temperatures in December and January range from 18 to 26° C (64.4 to 78.8 °F). The rainfall in the middle to late winter varies from 20 to 100 millimeters (0.8 to 3.9 in) annually on the central plains and coasts. The mountain's rainfall can reach 900 millimeters (35.4 inches), especially over Jebel Akhdar.

Oman's economy is mainly reliant on its oil and gas reserves. The oil was discovered in 1964, and the first oil exports occurred in 1967. Petroleum production and exports thereafter quickly took center stage in the national economy. Approximately two-fifths of the GDP and approximately three-fourths of the government's income come from oil profits. Oman's GDP increased by 1.3% in 2023. Foods, non-metallic mineral goods, chemicals, and chemical products are among Oman's non-petroleum manufacturing industries. By the end of 2023, the GDP rose from 37.7 billion Omani riyals (OMR) at the end of 2022 to 38.2 billion OMR. The value of non-oil operations increased by 2.4 percent to 27.3 billion OMR at the end of last year, from 26.6 billion OMR in 2022. This increase was the primary driver of growth. Between 2022 and 2023, oil activity increased by approximately 0.4 percent, from 12.3 billion OMR to 12.4 billion OMR. The industrial zones in Oman are Sohar Industrial Estate, Rusayl Industrial Estate, Sur, Raysut, Buraimi, Nizwa, Sumail, and Knowledge Oasis Muscat (KOM).



1.2

Environment

1.2.1 Clean energy transition

Oman has focused on addressing climate change through various public and private initiatives, including the Oman Vision 2040, which strongly emphasizes the transition to clean energy. Oman emphasizes developing renewable energy sources in its gradual transition to a low-carbon economy. It establishes a goal to increase the use of renewable energy from 0% in 2015 to 20% by 2030 and then to 35-39% by 2040. Oman's National Strategy for an Orderly Transition to Net Zero aims to achieve net zero by 2050 by focusing on five key areas: supply security, economic impact optimization, social ramifications, environmental sustainability, and reduced energy system costs. Adopting renewable power generation, electrification, enhancing energy efficiency, and switching to EVs are important priority levers. To provide a sufficient response to climate change, Oman created a National Spatial Strategy 2020-2040 to foresee the effects of climate change on infrastructure and urban areas and to incorporate adaptation and mitigation measures into new developments. Minamata Initial assessment (MIA) report, named after the well-known, Mercury-caused crisis in Minamata Bay (Japan) in the late 1950s, the Minamata Convention on Mercury is an international multilateral agreement aiming to limit worldwide

Mercury emissions and releases, exclusively from artificial activities and sources. After a lengthy debate and discussion lasting more than 15 years, the Convention became effective on 16 August 2017. One hundred and twenty-one countries have signed this Convention. Compared to other extremely toxic and hazardous metals (i.e., arsenic and lead), Mercury is considered a global pollutant with potential public and environmental health risks. Therefore, the Convention recognizes Mercury (as well as its compounds) for its persistence in the environment, long-range atmospheric transport, tendency to accumulate in various environmental matrices, and adverse effects on human well-being and ecosystems. The Minamata Convention on Mercury aims to protect human health and the environment from anthropogenic Mercury pollution. Therefore, its implementation is anticipated to substantially reduce emissions and releases of Mercury and its compounds from artificial sources. Mercury waste and Mercury-contaminated sites, etc., manufacturing processes involving Mercury and its compounds, health aspects, and other administrative, supportive, and technical-related articles (e.g., financial, education, reporting, etc.). The signatory countries/states must implement their obligations under the Convention. These include, but are not limited to,

controlling anthropogenic Mercury emission to the atmosphere and releases to the hydrosphere and lithosphere, phasing out and banning existing and future Mercury mines, respectively. Additionally, discontinuing and gradually reducing the use of Mercury and its compounds in some processes and products, unifying the national Mercury-related legislations to regulate gold mining, handling Mercury-containing waste/by-products, and addressing Mercury-contaminated and storage sites, and campaigning nationwide for raising public awareness of Mercury and its potential risks. Nevertheless, the Convention's text highlights the flexibility to accommodate and allow national development plans since it requires the allocation of financial resources and technical support to achieve the overall national reduction of Mercury emissions and releases.

Oman ratified the Convention on 28 May 2020 by the Royal Decree 5/8/2020 (Approving the Accession of the Sultanate of Oman to the Minamata Convention on Mercury) and has become the 122nd state/member since 21 September 2020. The Environment Authority, the competent national institution in the Sultanate of Oman, is responsible for implementing and following up on the obligations under the Minamata Convention on Mercury.

1.2.2 Mercury

Mercury is the only metallic element that is liquid at standard temperature and pressure. Chemically, it is represented by Mercury, and its atomic number is 80. It is also known as quicksilver. Mercury occurs in deposits around the planet, primarily as mercuric sulphide. Mercury is naturally released into the atmosphere as vapor by rock weathering, water body movement, forest fires, and biological processes. However, human activity is mainly responsible for the elevated Mercury levels in the environment. The estimates show that 10% of Mercury emissions into the atmosphere come from natural sources like volcanoes, 30% are caused by human activity, and the remaining 60% are thought to be re-emissions of Mercury from earlier human activities.

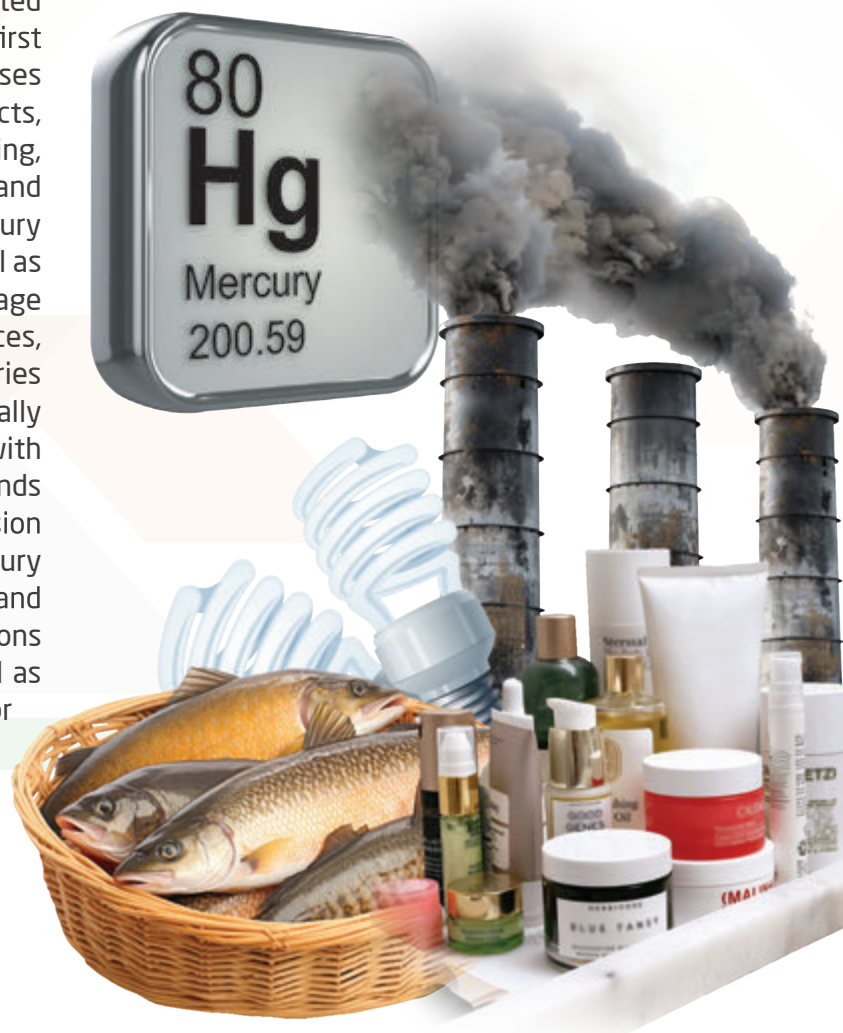
The every day use of Mercury includes thermometers, barometers, manometers, sphygmomanometers, Mercury switches, Mercury relays, fluorescent lights, and other devices. However, concerns have recently been raised regarding the toxicity of the elements, which led to a strong commitment to phasing out such Mercury-containing instruments. Mercury's serious adverse effects on human health and the environment are recognized as global concerns by the Minamata Convention on Mercury and the UNEP first Global Mercury Assessment. The toxic effects include brain, kidney, and lung damage. Mercury is hazardous to the neurological system; it primarily affects human health, particularly the development of young children's brains and spinal cord. High blood levels of methylmercury in infants and early children pose serious health hazards. In adults, they can result in

tremors, skin rashes, kidney, heart, and respiratory issues, headaches, weakness, memory issues, and mood disorders.

The Global Environment Facility (GEF) Council reviewed document GEF/C.4404/, Mercury Initial Assessment (MIA), laying the groundwork for the GEF to function as a component of the Minamata Convention. Thus, the Minamata Initial Assessment (MIA) was created to give nations the ability to decide whether to accept the Convention and to serve as a foundation for further efforts to bring it into effect. The following elements are suggested to be included in the MIA according to its first guidelines: (a) Legislation and policies: It addresses Mercury supply sources and trade, added products, manufacturing processes, small-scale gold mining, laws about air pollution and emissions, and releases origins. (b) Inventory of Mercury: Mercury stocks and/or Mercury compound stocks, as well as import and export protocols that evaluate storage conditions. Mercury supply, including sources, methods, and amounts of recycling. Industries that use Mercury and how much it is used annually include manufacturing processes and products with added Mercury. Trade in Mercury and compounds containing Mercury. (c) Identification: Emission sources of Mercury and release sources of Mercury to land and water. (d) Evaluation: identification and strengthening of the needs of national institutions necessary to carry out the Convention, as well as the institutional and capability requirements for its implementation.

The operations of this MIA project are aimed at comprehending the Mercury situation in the Sultanate of Oman. Activities supporting the design of targeted interventions include

evaluating mercury consumption and release patterns to assess national institutional and regulatory capacity to determine what institutional requirements are necessary to execute the treaty at the national level. The project completion will significantly advance national efforts to cut Mercury discharges and, consequently, Mercury exposure concerns, improving both environmental and public health. In turn, this will lessen Mercury discharges into the environment, benefiting local communities and the world.



1.2.3 Mercury contamination

The primary sources of Mercury contamination include industrial activities. For instance, mining, removing trash and molten metals, creating chemicals and fertilizers, and using natural sources. However, there are a variety of ways and sources of Mercury exposure. In developing nations, fossil fuels, mining, and religious and cultural rituals are the leading causes of Mercury pollution. The various Mercury pollution sources are recognized as anthropogenic sources of Mercury emissions: smelting of ores, artisanal gold mining, cement manufacture, burning of fossil fuels, and waste incineration. Small-scale gold mining involves heating elemental Mercury, which releases vapors into the atmosphere that settle as dust on the surface of water and soil. There are several types of Mercury: elemental (or metallic), inorganic (to which people may be exposed by their jobs), and organic (e.g., methylmercury, to which people may be exposed through their diet). The most dangerous type of Mercury is organic, which is present in pesticides, insecticides, and food chains (Ray, 2023).

Methylmercury is produced in aquatic ecosystems from inorganic Mercury, which makes it a crucial component of the biogeochemical cycle of Mercury. The study has reported fish contamination with Mercury: Mercury contamination has been found in several fish and shellfish species, and eating fish contaminated with Mercury carries several dangers. In Oman, the study reported by Al-Mughairi (2013) mentions an average quantity of Mercury in fresh and frozen fish was 0.02 mg/kg, whereas in canned fish, the value ranged from 0.02 mg/kg in sardines

to 0.18 mg/kg in tuna. With a mean concentration of 0.09 mg/kg, shellfish had slightly more Mercury than fresh or frozen fish. Most fish species (72%) had total Mercury contents over 5 kg; on the other hand, most shellfish species (66%) had total Mercury contents exceeding 5 kg. However, when 120 g of dried shark was consumed, risks were found when the weekly methylmercury intake exceeded the provisionally acceptable threshold of 1.6 µg/kg. Thus, to effectively lower the exposure to Mercury, populations that consume fish should decrease the amount of dried shark (Al-Mughairi, 2013).

The study has reported that one of the biggest health concerns is the build-up of organic Mercury (methyl or ethyl Mercury) in fish, poultry, and rice grains. In uncooked food, Mercury levels are found to be between 1.54 and 2.95 mg/kg (Kumar, 2023). Mercury was mainly used in thermometers, but more recently, the Mercury vapor lamp, tube light, and compact fluorescent lamp industries have found new uses for this metal (Kadam, 2019). Significant sources of Mercury contamination include the release of Mercury from industrial facilities, metal production, and the negligent disposal of products containing Mercury along with household waste (Sharma, 2019). Workers in fluorescent light recycling facilities risk developing health problems from Mercury exposure; it has been observed that when a fluorescent lamp is destroyed, a considerable concentration of Mercury is discharged (Jensen, 2021).

Artisanal and Small-scale Gold Mining (ASGM), although a considerable source of income, is also considered a source of mercury pollution due to the amalgamation process. ASGM is practiced in about

80 countries by close to 20 million individuals (about one third of whom are women and children) and has a direct/indirect impact on over 100 million people worldwide. Around 70 countries are home to an estimated 15 million individuals, 3 million of whom are women and children, who participate in ASGM in developing countries (Esdaile, 2018). They are frequently subjected to elevated concentrations of elemental Mercury. Every year, almost 30-50 million tons of electronic garbage are disposed of, which is said to produce Mercury, which is extremely dangerous for children's health (Dutta, 2018). When exposed to rain and wind, the disposal of thermometers, batteries, electrical switches, and fluorescent bulbs also promotes the entry of Mercury. Water seeping from mining sites enters rivers, lakes, and water streams where it collects Mercury over an extended period (Pant, 2024).

Another significant source of Mercury emissions into the atmosphere, contributing to 71% of total emissions, is coal combustion, of which 35% originates from power generation units and 46% from industrial plants (Streets, 2018). There is a risk of mercury pollution associated with the production of silver and other compounds, and mercury pollution varies depending on the country. According to Liang, (2015) global footprint of Mercury emissions is 1358 tons (56% of the total), with 66 tons (3% of the worldwide total) coming from North America (including the United States and Canada), 154 tons (6% of the global total) coming from 27 European Union countries, and 89 tons (4% of the worldwide total) coming from Latin America (including Brazil and Mexico). However, China is the country that contributes

the most to global atmospheric Mercury emissions, with 872 tons, which is 36% of the worldwide total (Liang, 2015). Mercury is also released into the air (20%), water (30%), soil (30%), and landfills (20%) according to the Toxic Release Inventory and the United States Environmental Protection Agency, coal-fired power stations are responsible for two thirds of all mercury emissions into the atmosphere (Joy and Qureshi, 2023; Horowitz, 2014).

1.3

Summary

“

This chapter includes Oman’s economic, geographical, and cultural information. Furthermore, the Environment Authority, the competent national institution in the Sultanate of Oman, is responsible for implementing and following up on the obligations under the Minamata Convention on Mercury. It is the focal point for coordinating the national Convention-related activities and communicating with the concerned international bodies (e.g., Secretariat of the Minamata Convention, the United Nations Environment Programme). Towards achieving its commitments for reducing Mercury emissions and releases, this report addresses the findings of the inventory of Mercury releases in Oman, which will be included later in the Mercury initial assessment (MIA) report. Finally, this chapter provides an overview and summary of the report and the MIA convention.

”



Chapter 2: Mercury Inventory and Identification of Emissions and Resources

2.1 Introduction

In 2021, the Environment Authority of Oman established a national committee for MIA. The committee has members from governmental and semi-governmental institutions, as well as organizations under Article (3) of Royal Decree No. (4695).

At least one to two members represent the committee from the concerned governmental and semi-governmental institutions and organizations, which are members of the national committee of sound management of chemicals established based on Article (3) of the royal decree no. (4695).

The organizations include:

- The Environment Authority is providing data on the production of other minerals and materials with Mercury impurities, the intentional use of Mercury in industrial processes, the production of recycled metals, waste incineration, waste deposition, landfilling, and wastewater treatment.
- The Ministry of Energy and Minerals is responsible for data collection on the extraction and use of fuels or energy sources and primary metal production.
- The Ministry of Health provides data on dental Mercury amalgam fillings and the use of manometers and gauges with Mercury.
- The Ministry of Foreign Affairs and Agricultural

and Marine Wealth and Water Resources covers information and sources.

- The Sultan Qaboos University for the academic research outcomes,
- Muscat Municipality.
- The ministry of defence.

The entities mentioned above are the key national stakeholders. The private sector is also represented by the related governmental organizations with which it has an association. The committee's work was enriched by several in-person and online workshops organized and offered with coordination between the Environment Authority and the United Nations Environment Programme (UNEP) and generously supported by the Global Environmental Facility (GEF).

The Level 2 of UNEP Toolkit for identifying and quantifying mercury releases- Inventory was employed to develop the national mercury inventory in Oman to locate and estimate key sources, emissions, and releases of mercury and mercury compounds. In principle, the methodology of inventory levels 1 and 2 is similar and based on mass balances for each Mercury release source type. Compared to the Toolkit Inventory Level 1, the Level 2 is more refined (i.e., more detailed and comprehensive so that all underlying factors can be tailored according to the available national

information), hence its use in Oman to conduct a better and more precise analysis.

The UNEP study evaluates Mercury leakage into rivers and lakes for the first time globally. According to the research, 260 tons of Mercury that had been stored in the soil (UNEP, 2013). There are continuous national and worldwide efforts to limit Mercury releases into the environment and significant environmental emissions due to deforestation and polluted locations with a higher Mercury release (UNEP, 2011). The yearly mobilization of soil and Mercury may rise by a further 20-25% compared to 2023 levels if deforestation keeps up its current exponential rate until 2030 (Diringer, 2019). Following the adoption of the Minamata Convention on Mercury, signatory nations will need to reduce their use of Mercury and create plans to limit Mercury exposure in vulnerable populations (UNEP, 2013).

This inventory report summarizes the anthropogenic sources and amounts calculated of Mercury emissions and releases based on data collected from February 2022 to December 2022. Therefore, 2022 represents the baseline data on which the future Oman Convention reports will be referenced. A series of meetings and workshops (chapter 5 and appendix) had been organized and conducted to facilitate the achievement of

the MIA. Stakeholder's representatives were introduced to the toolkit and guided thoroughly to identify Mercury sources and then quantify its emissions and releases from various sources. They gathered the data on Mercury inputs and releases, as well as their identified sources, as the data was collected based on the work distribution. Then the data was supplied to the focal point, the Environment Authority. The focal point, in coordination with the United Nations Environment Protection, the international expert,

and the national expert, revised the data, finalized calculations of Mercury amounts, and incorporated the suggested amendments after checking with the concerned stakeholders. Finally, the data, including Mercury emissions and releases, were tabulated and graphed. Estimating Mercury emissions and releases and identifying its sources would be challenging since no known sources are explicitly identified for anthropogenic Mercury in Oman (Al-Reasi et al., 2007; Al-Shidi et al., 2022). Moreover, these human

activities have discharged substantial amounts of Mercury into the air, land, and water (UNEP, 2018). However, Mercury monitoring initiatives combine with the UNEP Minamata Convention on Mercury, which seeks to reduce Mercury leakage to the environment (Sonke, 2023). However, utilizing UNEP's EP Toolkit Inventory Level 2 enabled the national committee for MIA to generate Mercury releases and emissions, which are summarized in the following sections.



2.2

Mercury release source

Table 2.1 shows which Mercury release sources were identified as present or absent in Oman. Only source types positively identified as present were included in the quantitative assessment

Source category		Source category		Source category	
Extraction and use of fuels/energy sources		Production of lime and light weight aggregates	N	Production of recycled metals («secondary» metal production)	
Coal combustion in power plants	N	Intentional use of Mercury in industrial processes		Production of recycled Mercury («secondary production»)	N
Coal combustion in coal fired industrial boilers	N	Chlor-alkali production with Mercury-technology	N	Production of recycled ferrous metals (iron and steel)	Y
Other coal use	N	VCM production with Mercury catalyst	N	Production of other recycled metals	Y
Mineral oils - extraction, refining and use	Y	Acetaldehyde production with Mercury catalyst	N	Waste incineration	
Natural gas - extraction, refining and use	Y	Other production of chemicals and polymers with Mercury	N	Incineration of municipal/general waste	N
Other fossil fuels - extraction and use	N	Consumer products with intentional use of Mercury		Incineration of hazardous waste	N
Biomass fired power and heat production	N	Thermometers with Mercury	Y	Incineration of medical waste	Y
Geothermal power production	N	Electrical switches and relays with Mercury	Y	Sewage sludge incineration	N
Primary (virgin) metal production		Light sources with Mercury	Y	Informal waste burning	N
Mercury (primary) extraction and initial processing	N	Batteries with Mercury	N	Waste deposition/landfilling and wastewater treatment	
Gold (and silver) extraction with Mercury amalgamation processes	N	Polyurethane with Mercury catalysts	N	Controlled landfills/deposits	Y
Zinc extraction and initial processing	N	Biocides and pesticides with Mercury	N	Diffuse disposal under some control	N
Copper extraction and initial processing	N	Paints with Mercury	N	Informal local disposal of industrial production waste	N
Lead extraction and initial processing	N	Pharmaceuticals for human and veterinary uses	N	Informal dumping of general waste	N
Gold extraction and initial processing	N	Cosmetics and related products with Mercury	N	Wastewater system/treatment	Y
Aluminum extraction and initial processing	N	Other intentional product/process use		Crematoria and cemeteries	
Other non-ferrous metals - extraction and processing	N	Dental Mercury-amalgam fillings	Y	Crematoria/cremation	Y
Primary ferrous metal production	N	Manometers and gauges with Mercury	Y	Cemeteries	N
Production of other minerals and materials with Mercury impurities		Laboratory chemicals and equipment with Mercury	Y		
Cement clinker production	Y	Mercury metal use in religious rituals and folklore medicine	N		
Pulp and paper production	N	Miscellaneous product uses, Mercury metal uses, and other sources	N		

Table 2.1 Identification of Mercury release sources in Oman; sources present (Y) and absent (N)

2.2.1 Data and inventory on Mercury from extraction and use of fuels/energy

Mercury is often released during the extraction and use of fuels and energy. The section below investigates the amount of Mercury released through these processes.

A. Specific sources of Mercury from extraction, refining and use of mineral oils

In Table 2.2 below, a summary of Mercury releases during the extraction and use of fuels and energy is given. For instance, Coal Combustion in Power Plants, Energy Sources: Mineral Oil Extraction, Refining and Use, Use of gasoline, diesel, light fuel oil, kerosene, LPG and other light to medium distillates, Natural gas extraction, refining and use, and other fossil fuels extraction and use.

The extraction of fossil fuels causes Mercury to be released into the water, provided there are no emission controls. The amount of Mercury released is 32.80 Kg Mercury/y. Further, fossil fuel refining causes Mercury to be released into the air and water. The amount released to air and water is 9.10 Kg Mercury/y and 360 Kg Mercury/y, respectively, provided there are no emission controls. Moreover, using fossil fuels by vehicles causes the release of Mercury into the air (6.72). In refining natural gas, the amount of Mercury released to the air is 0.78 under the condition of no Mercury removal.



Name of specific source	Location	Activity rate	Input factor(s)	Pollution abatement systems	Output distribution factors	Stack height(s) in meter
Coal Combustion in Power Plants						
Coal Wash Combustion (Hard Coal)	Oman	0	0.15	Combustion of Anthracite	0	70 - 80
Coal Combustion in Coal Fired Industrial Boilers						
Coal Wash Combustion in Industrial Boilers (Hard Coal)	Oman	0	0.15	Combustion of Hard Coal	0	70 - 80
Other Coal Use						
Coke Production	Oman	0	0.15	Combustion of Lignite	0	70 - 80
Other Coal Combustion	Oman	0	0.15	Combustion of Lignite	0	70 - 80
Energy Sources: Mineral Oil Extraction, Refining and Use						
Extraction	Oman	48,242,087	3.4	Oil Combustion facility with no emission controls	Water: 32.80	-
Refining	Oman	10,701,586	3.4	Oil Combustion facility with no emission controls	Air: 9.10, Water: 0.36 and Sector-Specific Treatment /Disposal: 5.46	-
Use of gasoline, diesel, light fuel oil, kerosene, LPG and other light to medium distillates:						
Transportation other than residential heating and oil combustion facilities	Oman	3,357,824	2	Oil Combustion facility with no emission controls	Air: 6.72	-
Residential heating with no controls	Oman	0	2	Oil Combustion facility with no emission controls	0	-
Other oil combustion facilities	Oman	201,885	2	Oil Combustion facility with no emission controls	0	-
Natural gas - extraction, refining and use:						
Extraction	Oman	-	100	Gas processing without Mercury removal	-	-
Refining	Oman	47,581	100	Gas processing without Mercury removal	Air: 0.78	-
Use of raw or pre-cleaned gas/Use of pipeline gas (consumer quality)	Oman	7,770,368	100	Gas processing without Mercury removal	-	-
Other fossil fuels - extraction and use						
Combustion of peat	Oman	0	117	-	0	-
Biomass fired power and heat production						
Biomass burning	Oman	0	0.03	-	0	-
Charcoal combustion	Oman	0	0.12	-	0	-
Units: input factor=g Mercury/t, activity rate=Coal, t/y and Output=Kg Mercury/y, 2021 and MIA report						

Table 2.2 Data and inventory on extraction and use of fuels/energy sources - Identified point sources in this source category.

B. Mercury inputs and outputs from extraction of mineral oils

Table 2.3 shows Mercury inputs and outputs during extraction of mineral oils. The Mercury goes into the water during extraction of mineral oils. The calculated output released to water is (32.28 Kg Hg/t).

Extraction of mineral oilsspecific sourc	Unit	Production	Use	Disposal
Activity rate	Oil t/y	48,242,087	-	-
Input factor for phase	mg Hg/t	3.4	-	-
Calculated input to phase	Kg Hg/t	164	-	-
Output distribution factors for phase:				
- Air	-	-	-	-
- Water	-	0.2	-	-
- Land	-	-	-	-
- Products	-	-	-	-
- General waste treatment	-	-	-	-
- Sector-specific waste treatment	-	-	-	-
Calculated outputs/releases to:				
- Air	-	-	-	-
- Water	Kg Hg/t	32.28	-	-
- Land	-	-	-	-
- Products	-	-	-	-
- Sector-specific waste treatment	-	-	-	-

Table 2.3 Mercury inputs and outputs from extraction of mineral oils (year 2021)

C. Mercury inputs and outputs from mineral oils refinement

Table 2.4 shows Mercury inputs and outputs during mineral oils refinement. The calculated output released to air (9.10 kg Hg/t), water (0.36 Kg Hg/t), and sector-specific waste treatment (5.46 Kg Hg/t).

Refining of mineral oils	Unit	Production	Use	Disposal
Activity rate	Oil t/y	10,701,586	-	-
Input factor for phase	mg Hg/t	3.4	-	-
Calculated input to phase	Kg Hg/t	36	-	-
Output distribution factors for phase:				
- Air	-	0.25	-	-
- Water	-	0.01	-	-
- Land	-	-	-	-
- Products	-	-	-	-
- General waste treatment	-	-	-	-
- Sector-specific waste treatment	-	0.15	-	-
Calculated outputs/releases to:				
- Air	Kg Hg/t	9.10	-	-
- Water	Kg Hg/t	0.36	-	-
- Land	-	-	-	-
- Products	-	-	-	-
- General waste treatment	-	-	-	-
- Sector specific waste treatment	Kg Hg/t	5.46	-	-

Table 2.4 Mercury inputs and outputs from mineral oils refinement (year 2021)

D. Mercury inputs and outputs from mineral oils use (transportation and other combustion facilities)

Table 2.5 shows Mercury inputs and outputs during the mineral oils use. The calculated output released to the air (6.72 Kg Hg/t).

Refining of mineral oils	Unit	Transportation			Other combustion facilities		
		Production	Use	Disposal	Production	Use	Disposal
Activity rate	Oil t/y	-	3,357,824	-	-	201,885	-
Input factor for phase	mg Hg/t	-	2.0	-	-	2.0	-
Calculated input to phase	Kg Hg/t	-	7	-	-	7	-
Output distribution factors for phase:							
- Air		-	1	-	-	1	-
- Water		-	-	-	-	-	-
- Land		-	-	-	-	-	-
- Products		-	-	-	-	-	-
- General waste treatment		-	-	-	-	-	-
- Sector-specific waste treatment		-	-	-	-	-	-
Calculated outputs/releases to:							
- Air		-	6.72	-	-	0.00	-
- Water		-	-	-	-	-	-
- Land		-	-	-	-	-	-
- Products		-	-	-	-	-	-
- General waste treatment		-	-	-	-	-	-
- Sector-specific waste treatment		-	-	-	-	-	-

Table 2.5 Mercury inputs and outputs from mineral oils use (year 2021)

E. Summary of inputs and results

Mercury is often released during the extraction and use of fuels and energy. The section investigates the amount of Mercury releases through the Coal Combustion in Power Plants, Energy Sources: Mineral Oil Extraction, Refining and Use, Use of gasoline, diesel, light fuel oil, kerosene, LPG and other light to medium distillates, Natural gas - extraction, refining and use, other fossil fuels - extraction and use. The maximum amount of mercury output release during the extraction of mineral oil to water, subsequently reduced into the air and sector specific showed the minimum range during mineral oil refining.

2.2.2 Data and inventory on Mercury from primary (virgin) metal production

The primary metal production is another source of Mercury contamination. The Mercury releases from all specific sources of virgin metal production could be, Mercury (primary) extraction and initial processing, silver extraction with Mercury amalgamation processes, zinc, copper and lead extraction and initial processing mining and concentrating, Aluminium extraction and initial processing (alumina production from bauxite and primary ferrous metal production). The study found no activity rate/zero activity rate. The Sultanate of Oman has the elements of geographical location, distinctive geological diversity, and appropriate logistical structure. Establish mining projects for various metallic and industrial minerals such as copper, chromium, manganese, gold, lead, silver, gypsum, and salt. This sector is considered one of the promising sectors that can enhance the Government's efforts in economic diversification. Ministry of Energy and Minerals and the Oman Minerals Development Company are the Government's support in the mining sector in Oman. Therefore, the agreement has been signed to invest 12 concessions in mineral exploration in 2023. Many recent national reports confirm the ability of the mining sector in Oman to achieve remarkable growth after the recent discovery of large quantities of minerals such as copper and many other rare earth elements. Hence, as no data was available about these mentioned investments and the old existing ones, no data has been recorded as no database has been developed. Furthermore, in line with Oman's Vision 2040 towards economic diversification, by optimizing the exploitation of natural resources and renewable energy available in Oman. Oman is working to develop a national mineral resource strategy that plays a massive role in supporting the national economy.

2.2.3 Data and inventory on Mercury from intentional use of Mercury in industrial processes

The use of Mercury in industrial processes is another source of Mercury contamination. The section below investigates the amount of Mercury released through the use of Mercury in industrial processes. The Mercury goes into the environment through industrial processes in two ways. For instance, Chlor-alkali production (with Mercury-technology) and vinyl chloride monomer (VCM) production (with Mercury catalyst, Acetaldehyde production with Mercury catalyst, and other production of chemicals and polymers with Mercury). Here, three sources are investigated: Electrical switches and relays with Mercury (production, use, and disposal), Light sources with Mercury (production, use, and disposal), and Polyurethane with Mercury catalysts. Table 2.6 shows Mercury inputs and outputs from the use of intentional Mercury in industrial processes. The study did not find any Mercury release from these activities. There is no output distribution of Mercury released through industrial processes.

Name of specific source	Location	Activity rate	Input factor(s)	Pollution abatement systems	Output distribution factors	Stack height(s) in meter
Electrical switches and relays with Mercury						
Production	Oman	-	1			
Use + disposal	Oman	4,436,897.08	0.14	Separate collection. Informal waste handling. widespread	0	
Light sources with Mercury						
Production/Use + disposal	Oman	22,902.393	1	Production of Mercury	-	
Fluorescent tubes (double end)	Oman	-	8	Separate collection. Controlled waste handling	-	
Compact fluorescent lamp (CFL single end)	Oman	-	2.7	Separate collection. Informal waste handling. widespread	-	
High pressure Mercury vapour	Oman	-	40	Separate collection. Controlled waste handling	-	
High-pressure sodium lamps	Oman	-	20	-	-	
UV light for tanning	Oman	-	15	-	-	
Metal halide lamps	Oman	-	25	-	-	
Polyurethane with Mercury catalysts						
Use + disposal	Oman	0.03	-	Separate collection. Informal waste handling. widespread		
Units: input factor=g Hg/t, activity rate=Coal, t/y and Output=Kg Hg/y						

Table 2.6 Mercury inputs and outputs from intentional use of Mercury in industrial processes

2.2.4 Data and inventory on Mercury from consumer products with intentional use of Mercury

Consumer products are another source of Mercury. The section below investigates the amount of Mercury released through consumer products.

A. Specific sources of Mercury from consumer products

Table 2.7 below gives a summary of Mercury releases from all specific consumer product sources. The production of thermometers with Mercury, such as medical thermometers, ambient air thermometers, industrial and special thermometers, and other glass Mercury thermometers. Using thermometers with Mercury, such as medical thermometers, ambient air thermometers, industrial and special thermometers, and other glass Mercury thermometers. The production, use, and disposal of electrical switches and relays with Mercury. The production, use, and disposal of light sources with Mercury, such as fluorescent tubes (double end), compact fluorescent lamp (CFL single end), high-pressure Mercury vapour, high-pressure sodium lamps, UV light for tanning, and metal halide lamps. The production, use, and disposal of batteries with Mercury, such as Mercury-zinc cells, Zinc-air button cells, alkaline button cells, and silver oxide button cells,

Alkaline, and other than button cell shapes. The production, use, and disposal of Polyurethane with Mercury catalysts, Biocides and pesticides with Mercury, Paints with Mercury, Pharmaceuticals for human and veterinary uses, and Cosmetics and related products with Mercury.

Name of specific source	Location	Activity rate	Input factor(s)	Pollution abatement systems	Output distribution factors	Stack height(s) in meter
Thermometers with Mercury: Production						
Medical thermometers	Oman	0	1	-	0	-
Ambient air thermometers	Oman	0	3.5	-	0	-
Industrial and special thermometers	Oman	0	103	-	0	-
Other glass Mercury thermometers	Oman	0	20.5	-	0	-
Thermometers with Mercury: Use + disposal						
Medical thermometers	Oman	0	0.15	No separate collection. Controlled waste handling	0	
Ambient air thermometers	Oman	0	0.002	No separate collection. Informal waste handling, widespread	0	
Industrial and special thermometers	Oman	0	0.014	Separate collection. Controlled waste handling	0	
Other glass Mercury thermometers	Oman	0	0.015	-	0	
Electrical switches and relays with Mercury						
Production	Oman	-	1			
Use + disposal	Oman	4,436,897.08	0.14	No separate collection. Informal waste handling, widespread	0	
Light sources with Mercury						
Production/Use + disposal	Oman	22,902.393	1	Production of Mercury	-	
Fluorescent tubes (double end)	Oman	-	8	No separate collection. Controlled waste handling	-	
Compact fluorescent lamp (CFL single end)	Oman	-	2.7	No separate collection. Informal waste handling, widespread	-	
High pressure Mercury vapour	Oman	-	40	Separate collection. Controlled waste handling	-	

High-pressure sodium lamps	Oman	-	20	-	-
UV light for tanning	Oman	-	15	-	-
Metal halide lamps	Oman	-	25	-	-
Batteries with Mercury/production					
Mercury oxide (all sizes); also called Mercury-zinc cells	Oman	0	320	No separate collection. Controlled waste handling	
Zinc-air button cells	Oman	0	12	No separate collection. Informal waste handling, widespread	
Alkaline button cells	Oman	0	5	Separate collection. Controlled waste handling	
Silver oxide button cells	Oman	0	4	-	
Alkaline, other than button cell shapes	Oman	0	0.25	-	
Batteries with Mercury /Use + disposal:					
Mercury oxide (all sizes); also called Mercury-zinc cells	Oman	0	320		
Zinc-air button cells	Oman	-	12		
Alkaline button cells	Oman	-	5		
Silver oxide button cells	Oman	-	4		
Alkaline, other than button cell shapes	Oman	-	0.25		
Polyurethane with Mercury catalysts					
Production (a)	Oman	-	0	No separate collection. Controlled waste handling	
Use + disposal	Oman	0.0	-	No separate collection. Informal waste handling, widespread	
Biocides and pesticides with Mercury					
Production (a)	Oman	0	1		
Use + disposal	Oman	-	0		

		Paints with Mercury	
Production (a)	Oman	0	1
Use + disposal	Oman	0	2.6
		Pharmaceuticals for human and veterinary uses	
Production (a)	Oman	-	-
Use + disposal	Oman	-	-
		Cosmetics and related products with Mercury	
Production (a)	Oman	0	1
Use + disposal	Oman	0	30
Units: input factor=g Hg/t, activity rate=Coal, t/y and Output=Kg Hg/y			

Table 2.7 Consumer products with intentional use of Mercury as a source of Mercury



B. Mercury inputs and outputs from the uses of Thermometers with Mercury

Table 2.8 shows Mercury inputs and outputs from the use of mercury Thermometers. There is no data on the release of Mercury from the use of mercury thermometers, such as medical thermometers, ambient air thermometers, industrial and special thermometers, and other glass Mercury thermometers.

Thermometers with Mercury	Unit	Production	Use	Disposal
Activity rate	Oil t/y	94,147.828	-	-
Input factor for phase	mg Hg/t	20.5	-	-
Calculated input to phase	Kg Hg/t	0	-	-
Output distribution factors for phase:				
- Air	-	-	-	-
- Water	-	-	-	-
- Land	-	-	-	-
- Products	-	-	-	-
- General waste treatment	-	-	-	-
- Sector-specific waste treatment	-	-	-	-
Calculated outputs/releases to:				
- Air	-	-	-	-
- Water	-	-	-	-
- Land	-	-	-	-
- Products	-	-	-	-
- General waste treatment	-	-	-	-
- Sector-specific waste treatment	-	-	-	-

Table 2.8 Mercury inputs and outputs from the uses of Thermometers with Mercury

C. Mercury inputs and outputs from uses of electrical switches and relays

Table 2.9 shows Mercury inputs and outputs from the use of electrical switches and relays with Mercury. There is no data on the release of Mercury from the use of electrical switches and relays with Mercury, such as light sources with Mercury, such as fluorescent tubes (double end), compact fluorescent lamps (CFL single end), high-pressure Mercury vapour, high-pressure sodium lamps, UV light for tanning, and metal halide lamps.

Electrical switches and relays with Mercury	Unit	Production	Use	Disposal
Activity rate	Oil t/y	4,436,897.08	-	-
Input factor for phase	mg Hg/t	0.14	-	-
Calculated input to phase	Kg Hg/t	621	-	-
Output distribution factors for phase:				
- Air	-	0.01	-	-
- Water	-	-	-	-
- Land	-	-	-	-
- Products	-	-	-	-
- General waste treatment	-	-	-	-
- Sector-specific waste treatment	-	-	-	-
Calculated outputs/releases to:				
- Air	-	-	-	-
- Water	-	-	-	-
- Land	-	-	-	-
- Products	-	-	-	-
- General waste treatment	-	-	-	-
- Sector-specific waste treatment	-	-	-	-

Table 2.9 Mercury inputs and outputs from the use of electrical switches and relays with Mercury

D. Summary of inputs and results

The Mercury releases from consumer products production, use, and disposal are investigated. There is no data on the release of Mercury from using thermometers with Mercury, such as medical thermometers, ambient air thermometers, industrial and special thermometers, and other glass Mercury thermometers. Data and inventory on Mercury from other intentional product/process uses can also be found from intentional product/process uses. The amount of Mercury released by recycled metals is examined in the following section.

E. Specific sources of Mercury from intentional product/process uses

Table 2.10 below gives a summary of Mercury releases from all specific sources of other intentional product/process uses. The particular sources are (a) fillings at dentist clinics (amalgam fillings/preparations, Mercury supply for amalgam fillings, releases from Mercury supply for fillings 10-20 years ago), (b) Manometers and gauges with Mercury, and (c) laboratory chemicals and equipment with Mercury. Consumer products are another source of Mercury. The section below investigates the amount of Hg released through consumer products.

The Ministry of Health in Oman, represented by the Environmental and Occupational Health Department of the General Directorate of Disease Surveillance and Control, has developed "National Guide to Poison Treatment". The Sultanate of Oman has taken advanced steps in the prevention and response to chemical-related toxic emergencies, noting that a national committee for health and environment was formed at the end of 2017 to create a national strategy for environmental health. The Ministry of Health has established the National Poison Control Centre and developed an electronic surveillance system for poisons and infections within the National Surveillance Program "Rasd". Most cases received in this centre were noticed because of insufficient awareness of the optimal and positive use of materials, medicines, and chemical tools around us, making health education an urgent need when dealing with these materials and others.

F. Specific sources of Hg from consumer products

Table 2.10 below summarizes Mercury releases from all specific consumer product sources. The primary sources of mercury include thermometers, the use and disposal of light sources, electrical switches, batteries, mercury cells, and mercury catalysts. In addition, the other sources include mercury-containing biocides, pesticides, paints, cosmetics, and pharmaceuticals for human and veterinary uses with mercury.

Name of specific source	Location	Activity rate	Input factor(s)	Pollution abatement systems	Output distribution factors	Stack height(s) in meter
Dental Mercury- fillings at dentist clinics						
Amalgam fillings/preparations	Oman	-	-	Preparations of fillings at dentist clinics (input is current Mercury supply for amalgam fillings); (a)	Water: 0.33, Products: 0.22, General Wastes: 0.95 and Specific Treatment/Disposal: 0.88	
Current Mercury supply for amalgam fillings	Oman	-	0.02	Preparations of fillings at dentist clinics (input is current Mercury supply for amalgam fillings); (a)	0	-
Use - from fillings in the mouth (releases from Mercury supply for fillings 5-15 years ago)	Oman	12.643	-	Use (input is Mercury supply for fillings 5-15 years ago) (a)	Water: 0.25	-
Disposal (releases from Mercury supply for fillings 10-20 years ago)		3.684	-	Disposal (input is Mercury supply for preparation of fillings 10-20 years ago (a) - In countries where most dental clinics are equipped with high-efficiency amalgam filters (95% retention rate), and - In countries where only dental chair filters/strainers are used in most clinics	Water: 0.07, Products: 0.22, General Wastes: 0.96 and Specific Treatment/Disposal: 0.88	
Manometers and gauges with Mercury						
Production (c)	Oman	1	-			
Use + disposal of medical blood pressure gauges	Oman	0.0 g Mercury item/y	80	(a1) No separate collection. Controlled waste handling. (a2) No separate collection. Informal waste handling. Widespread (a3) Separate collection. Controlled waste handling.	Air: 18.98, Water: 56.93, General Wastes: 56.93 and Specific Treatment/Disposal: 56.93	
Laboratory chemicals and equipment with Mercury						
Laboratory chemicals	Oman	4,527,446	0.01		Water: 14.94, General Wastes: 14.94 and Specific Treatment/Disposal: 15.39	
Other laboratory equipment (level 1 default for group)	Oman	4,527,446	0.04	No separate collection. Informal waste handling. widespread	Water: 59.76, General Wastes: 59.76 and Specific Treatment/Disposal: 61.57	
Light sources with Mercury						

Table 2.10 Specific sources of Mercury from other intentional product/process uses

G. Mercury inputs and outputs from other intentional product/process and use of Manometers and gauges

Table 2.11 shows Mercury inputs and outputs from the use of Manometers and gauges with Mercury. Mercury's key releases are air, water, sector-specific waste treatment, and general waste treatment. The calculated output release is to air (18.98 kg Hg/t), water (56.93 kg Hg/t), sector-specific waste treatment (56.93 kg Hg/t), and general waste treatment (56.93 kg Hg/t).

Manometers and gauges with Mercury	Unit	Production	Use (g Hg/y)	Disposal (g Hg item/y)
Activity rate	Oil t/y	2,372	-	-
Input factor for phase	mg Hg/t	80	-	-
Calculated input to phase	Kg Hg/t	190	-	-
Output distribution factors for phase:				
- Air	-	0.01	-	-
- Water	-	0.005	-	-
- Land	-	-	-	-
- Products	-	-	-	-
- General waste treatment	-	0.1	-	-
- Sector-specific waste treatment	-	0.01	-	-
Calculated outputs/releases to:				
- Air	-	18.98	-	-
- Water	-	56.93	-	-
- Land	-	-	-	-
- Products	-	-	-	-
- General waste treatment	-	56.93	-	-
- Sector-specific waste treatment	-	56.93	-	-

Table 2.11 Mercury inputs and outputs from the uses of Manometers and gauges with Mercury

H. Mercury inputs and outputs from other intentional product/ Laboratory chemicals and equipment

Table 2.12 shows Mercury inputs and outputs from using laboratory chemicals and equipment with Mercury. The key Mercury releases here are releases to air, sector-specific waste treatment, and general waste treatment. The calculated output release is to air (14.94 kg Hg/t), sector-specific waste treatment (15.39 kg Hg/t), and general waste treatment (14.94 kg Hg/t).

Laboratory chemicals and equipment with Mercury	Unit	Production	Use (g Hg/y)	Disposal (g Hg/y)
Activity rate	Oil t/y	4,527,446	-	-
Input factor for phase	mg Hg/t	0.01	-	-
Calculated input to phase	Kg Hg/t	54.27	-	-
Output distribution factors for phase:				
- Air	-	-	-	-
- Water	-	0.33	-	-
- Land	-	-	-	-
- Products	-	-	-	-
- General waste treatment	-	0.33	-	-
- Sector-specific waste treatment	-	0.34	-	-
Calculated outputs/releases to:				
- Air	-	14.94	-	-
- Water	-	-	-	-
- Land	-	-	-	-
- Products	-	-	-	-
- General waste treatment	-	14.94	-	-
- Sector-specific waste treatment	-	15.39	-	-

Table 2.12 Mercury inputs and outputs from the uses of laboratory chemicals and equipment

I. Mercury inputs and outputs from other intentional product/ other laboratory equipment

Table 2.13 shows Mercury inputs and outputs from other intentional products/laboratory equipment. The key Mercury releases here are releases to water, sector-specific waste treatment, and general waste treatment. The calculated output release is to water (59.76 kg Hg/t), sector-specific waste treatment (61.57 kg Hg/t), and general waste treatment (59.76 kg Hg/t).

Other laboratory equipment	Unit	Production	Use (g Hg/y)	Disposal (g Hg/y)
Activity rate	Oil t/y	4,527,446	-	-
Input factor for phase	mg Hg/t	0.04	-	-
Calculated input to phase	Kg Hg/t	181.10	-	-
Output distribution factors for phase:				
- Air	-	-	-	-
- Water	-	0.33	-	-
- Land	-	-	-	-
- Products	-	-	-	-
- General waste treatment	-	0.33	-	-
- Sector-specific waste treatment	-	0.34	-	-
Calculated outputs/releases to:				
- Air	-	-	-	-
- Water	-	59.76	-	-
- Land	-	-	-	-
- Products	-	-	-	-
- General waste treatment	-	59.76	-	-
- Sector-specific waste treatment	-	61.57	-	-

Table 2.13 Mercury inputs and outputs from other intentional product/ other laboratory equipment

J. Summary of inputs and results

The Mercury releases from all specific sources of other intentional product/process uses are (a) fillings at dentist clinics (amalgam fillings/preparations, Mercury supply for amalgam fillings, releases from Mercury supply for fillings 10-20 years ago), (b) Manometers and gauges with Mercury, and (c) laboratory chemicals and equipment with Mercury. The maximum output released from using manometers and gauges resulted in a similar amount of water, sector-specific and general wastewater treatment, and subsequently released into the air. However, the amount released from laboratory chemicals and equipment is maximum for the sector-specific waste treatment and subsequent amounts released into the air and general waste treatment. Furthermore, using other intentional products resulted in maximum waste treatment and reduced amounts in the sector-specific and by the use of laboratory equipment.

2.2.5 Data and inventory on Mercury from production of recycled metals

Recycled metals are another source of Mercury. The section below investigates the amount of Mercury released through recycled metals.

A. Specific sources of Mercury from Production of recycled metals

A list of all the Mercury emissions from different types of recycled metals is provided in Table 2.14 below. The specific sources include (a) Production of recycled Mercury («secondary production»), (b) Production of recycled ferrous metals (iron and steel), and (c) Production of other recycled metals.

Name of specific source	Location	Activity rate	Input factor(s)	Pollution abatement systems	Output distribution factors	Stack height(s) in meter
Source category: Production of recycled metals ("secondary" metal production)						
Production of recycled Mercury ("secondary production")	Oman	0	1.00452	-		
Production of recycled ferrous metals (iron and steel)	Oman	1,800	1.1		Air: 0.65, Land: 0.67 and General Wastes: 0.65	-
Production of other recycled metals	Oman	530,900	-			-
Units: input factor=g Hg/t, activity rate=Coal, t/y and Output=Kg Hg/y						

Table 2.14 Specific sources of Mercury from recycled metals

B. Mercury inputs and outputs from the production of recycled metals

Table 2.15 shows Mercury inputs and outputs from the production of recycled ferrous metals (iron and steel). The key Mercury releases here are releases to water, land, and general waste treatment. The calculated output releases are water (0.33 Kg Hg/t), land (0.34 Kg Hg/t), and general waste treatment (0.33 Kg Hg/t).

Production of recycled ferrous metals (iron and steel)	Unit	Production	Use	Disposal
Activity rate	Oil t/y	1,800	-	-
Input factor for phase	mg Hg/t	1.1	-	-
Calculated input to phase	Kg Hg/t	1.98	-	-
Output distribution factors for phase:				
- Air	-	-	-	-
- Water	-	0.33	-	-
- Land	-	0.34	-	-
- Products	-	-	-	-
- General waste treatment	-	0.33	-	-
- Sector-specific waste treatment	-	-	-	-
Calculated outputs/releases to:				
- Air	-	0.65	-	-
- Water	-	-	-	-
- Land	-	0.67	-	-
- Products	-	-	-	-
- General waste treatment	-	0.65	-	-
- Sector-specific waste treatment	-	-	-	-

Table 2.15 Mercury inputs and outputs from the production of recycled iron and steel

C. Summary of inputs and results

The Mercury emissions from all distinct waste burning and incinerator sources are studied in this section. The specific sources include (a) Production of recycled Mercury («secondary production»), (b) Production of recycled ferrous metals (iron and steel), and (c) Production of other recycled metals. The study identified the significant Mercury leaks from recycled ferrous metals (iron and steel). The maximum and minimum amounts of land were noted for the water and general waste treatment.

2.2.6 Data and inventory on Mercury from waste incineration and burning

Waste incineration and burning often release Mercury traces, which contaminate the air, water, and soil. The section below investigates the amount of Mercury released through waste incineration and burning.

A. Specific sources of Mercury from Waste incineration

In Table 2.16 below, a summary of Mercury releases from all specific sources of waste incineration and burning is given. The particular sources are (a) Incineration of municipal/general waste, (b) Incineration of hazardous waste, (c) Incineration of medical waste, (d) Sewage sludge incineration, and (e) Open waste burning on landfills and informally.

Name of specific source	Location	Activity rate	Input factor(s)	Pollution abatement systems	Output distribution factors	Stack height(s) in meter
Source category: Waste incineration						
Incineration of municipal/general waste	Oman	0	1	Acid gas control with lime and activated carbon	-	-
Incineration of hazardous waste	Oman	0	24	Acid gas control with lime and activated carbon	-	-
Incineration of medical waste	Oman	1,765.5792	24	Acid gas control with lime and activated carbon	Air: 21.19, Sector-specific treatment / disposal: 21.19	-
Sewage sludge incineration	Oman	0	2	-	-	-
Open waste burning on landfills and informally	Oman	0	1	-	-	-
Units: input factor=g Hg/t, activity rate=Coal, t/y and Output=Kg Hg/y						

Table 2.16 Specific sources of Mercury from Waste incineration

B. Mercury inputs and outputs from the Waste incineration

Table 2.17 shows Mercury inputs and outputs from medical waste incineration. The key Mercury releases here are releases to air and sector-specific waste treatment. The calculated output releases are Air (21.19 kg Hg/t) and Water (21.19 kg Hg/t). The water and land bodies remained unaffected.

Incineration of medical waste	Unit	Production	Use	Disposal
Activity rate	Oil t/y	1,765.5392	-	-
Input factor for phase	mg Hg/t	24	-	-
Calculated input to phase	Kg Hg/t	42	-	-
Output distribution factors for phase:				
- Air	-	1	-	-
- Water	-	-	-	-
- Land	-	-	-	-
- Products	-	-	-	-
- General waste treatment	-	-	-	-
- Sector-specific waste treatment	-	1	-	-
Calculated outputs/releases to:				
- Air	-	21.19	-	-
- Water	-	-	-	-
- Land	-	-	-	-
- Products	-	-	-	-
- General waste treatment	-	-	-	-
- Sector-specific waste treatment	-	21.19	-	-

Table 2.17 Mercury inputs and outputs from the incineration of medical waste

C. Test of waste and wastewater default factors

In this inventory, default input factors were used to estimate Mercury releases from general waste treatment and wastewater treatment. The default factors were based on literature data on Mercury contents in waste and wastewater, which were only available from developed countries. The following test was performed to qualify the results for these sources.

The test made for general waste compares the calculated inputs to all four general waste sub-categories with the sum of general waste outputs from intentional Mercury uses in products plus processes as follows, using data from the Inventory Level 2 spreadsheet:

In the (unaltered) IL2 spreadsheet, the test was done as follows: tab «Level 2-Summary»:

$$(E61+E65+E67+E70) > 2*(J24 + \sum (J37 \text{ to } J55)).$$

The test made for wastewater compares the calculated inputs to wastewater treatment with the sum of outputs to water from intentional Mercury uses in products plus processes, as follows: using data from the Inventory level 2 spreadsheet: In the IL2 spreadsheet, the test was done as follows: tab «Level 2-Summary»:

$$E71 > 2*(G24 + \sum (G37 \text{ to } G55)).$$

D. Summary of inputs and results

The Mercury released from all specific sources of waste incineration and burning is investigated. The particular sources are (a) Incineration of municipal/general waste, (b) Incineration of hazardous waste, (c) Incineration of medical waste, (d) Sewage sludge incineration, and (e) Open waste burning on landfills and informally. The study found the key Mercury releases from the incineration of medical waste. The key Mercury released from the incineration of medical waste is released into the air and the sector-specific waste treatment; however, the water and land bodies remain unaffected.



2.2.7 Data and inventory on Mercury from waste disposal, deposition/landfilling

Waste disposal and landfilling often carry Mercury traces. Mercury contaminates the air, water, and soil. The section below investigates the amount of Mercury released through waste disposal and deposition/landfilling.

A. Specific sources of Mercury from Waste deposition/landfilling and wastewater treatment

Table 2.18 below gives a summary of Mercury releases from all specific sources of Waste deposition/landfilling and wastewater treatment. The particular sources are (a) Controlled landfills/deposits, (b) Diffuse disposal under some control, (c) Informal local disposal of industrial production waste, (d) Informal dumping of general waste, (e) Wastewater system/treatment.

Name of specific source	Location	Activity rate	Input factor(s)	Pollution abatement systems	Output distribution factors	Stack height(s) in meter
Source category: Waste deposition/landfilling and wastewater treatment						
Controlled landfills/deposits	Oman	2,583,824.44	1	-	Air: 25.84 and Water: 0.26	-
Diffuse disposal under some control	Oman	0	-	No treatment; direct release from sewage pipe	-	-
Informal local disposal of industrial production waste	Oman	0	-	Mechanical treatment only	-	-
Informal dumping of general waste	Oman	0	1	Mechanical and biological (activated sludge) treatment; no land application of sludge	-	-
Waste water system/treatment	Oman	86,007,518	5.25	Mechanical and biological (activated sludge) treatment; 40% of sludge used for land application	Water: 225.78, General Wastes: 135.46 and Sector specific treatment /disposal: 90.31	-
Units: input factor=g Hg/t, activity rate=Coal, t/y and Output=Kg Hg/y						

Table 2.18 Waste deposition/landfilling and wastewater treatment

B. Mercury inputs and outputs from Controlled landfills/deposits

Table 2.19 shows Mercury inputs and outputs from Controlled landfills/deposits. The key Mercury releases here are to air and water. The calculated output releases are Air (25.84 mg Hg/t) and Water (0.26 mg Hg/t). The land bodies remained unaffected.

Controlled landfills/deposits	Unit	Production	Use	Disposal
Activity rate	Oil t/y	2,583,824.44	-	-
Input factor for phase	mg Hg/t	1	-	-
Calculated input to phase	Kg Hg/t	2,584	-	-
Output distribution factors for phase:				
- Air	-	0.01	-	-
- Water	-	0.0001	-	-
- Land	-	-	-	-
- Products	-	-	-	-
- General waste treatment	-	-	-	-
- Sector-specific waste treatment	-	-	-	-
Calculated outputs/releases to:				
- Air	-	25.84	-	-
- Water	-	0.26	-	-
- Land	-	-	-	-
- Sector-specific waste treatment	-	-	-	-

Table 2.19 Mercury inputs and outputs from the Controlled landfills/deposits

C. Mercury inputs and outputs from the wastewater treatment

Table 2.20 shows Mercury inputs and outputs from wastewater treatment. The key Mercury releases here are releases to water, general waste treatment, and sector-specific waste treatment. The calculated output release is 225.77 Kg Hg/t, 135.46 Kg Hg/t, and 90.31 Kg Hg/t, respectively. The air and land bodies remained unaffected.

Wastewater system/treatment	Unit	Production	Use	Disposal
Activity rate	Oil t/y	86,007,518	-	-
Input factor for phase	mg Hg/t	5.25	-	-
Calculated input to phase	Kg Hg/t	452	-	-
Output distribution factors for phase:				
- Air	-	-	-	-
- Water	-	0.5	-	-
- Land	-	-	-	-
- Products	-	-	-	-
- General waste treatment	-	0.3	-	-
- Sector-specific waste treatment	-	0.3	-	-
Calculated outputs/releases to:				
- Air	-	-	-	-
- Water	-	225.77	-	-
- Land	-	-	-	-
- Products	-	-	-	-
- General waste treatment	-	135.46	-	-
- Sector-specific waste treatment	-	90.31	-	-

Table 2.20 Mercury inputs and outputs from the wastewater treatment

D. Summary of inputs and results

The key Mercury releases here are releases to air (the atmosphere), water (marine and freshwater bodies, including via wastewater systems), land, general waste, and sector-specific waste, which are investigated in this section. The specific sources studied are (a) Controlled landfills/deposits, (b) Diffuse disposal under some control, (c) Informal local disposal of industrial production waste, (d) Informal dumping of general waste, (e) Wastewater system/treatment. In controlled landfills/deposits, the key Mercury releases are released into the air and reduced amounts into the water. However, the land bodies remained unaffected. In the case of wastewater treatment, the key Mercury releases are from the maximum amount into water, general waste treatment, and sector-specific waste treatment, respectively. However, the air and land bodies remained unaffected.

2.2.8 Data and inventory on Mercury from crematoria and cemeteries

Crematoria and cemeteries are additional sources of Mercury. When people burn dead bodies or put them in cemeteries, a certain amount of Mercury is released. The section below investigates the amount of Mercury released.

A. Crematoria and cemeteries as source

Table 2.21 below gives a summary of Mercury releases from all source categories present. The key Mercury releases here are releases to air (the atmosphere), water (marine and freshwater bodies, including via wastewater systems), land, general waste, and sectors specific waste are investigated.

Name of specific source	Location	Activity rate	Input factor(s)	Pollution abatement systems	Output distribution factors	Stack height(s) in meter
Source category: Crematoria and cemeteries						
Crematoria/cremation	Oman	24	4	-	Air: 0.10	-
Cemeteries	Oman	0	4	-	-	-
Units: input factor=g Hg/t, activity rate=Coal, t/y and Output=Kg Hg/y						

Table 2.21 Crematoria and cemeteries as source

B. Mercury inputs and outputs from the Crematoria/cremation

Table 2.22 shows Mercury inputs and outputs from the Crematoria/cremation. The key Mercury releases here are releases to the air (the atmosphere). The calculated output release is 0.10 Kg Hg/t unit. The water and land bodies remained unaffected.

Crematoria/cremation	Unit	Production	Use	Disposal
Activity rate	Oil t/y	24	-	-
Input factor for phase	mg Hg/t	4	-	-
Calculated input to phase	Kg Hg/t	0.096	-	-
Output distribution factors for phase:				
- Air	-	1	-	-
- Water	-	-	-	-
- Land	-	-	-	-
- Products	-	-	-	-
- General waste treatment	-	-	-	-
- Sector-specific waste treatment	-	-	-	-
Calculated outputs/releases to:				
- Air	-	0.10	-	-
- Water	-	-	-	-
- Land	-	-	-	-

Table 2.22 Detailed results of Mercury inputs and outputs from the Crematoria/cremation

C. Summary of inputs and results

The key Mercury releases here are releases to air (the atmosphere), water (marine and freshwater bodies, including via wastewater systems), land, general waste, and sector-specific waste, which are investigated in this section. The study found that releases to air (the atmosphere) and water and land bodies remained unaffected.

2.2.9 Results of Mercury from resources

Table 2.23 below gives a summary of Mercury releases from all source categories present. Mercury's key releases are releases to air (the atmosphere), water (marine and freshwater bodies, including via wastewater systems), land, general waste, and sector-specific waste. An additional output pathway is «by-products and impurities» which designates Mercury to flow back into the market with by-products and products. See Table 2.23 below for a more detailed description and definition of the output pathways. Note that the following source sub-categories made the most significant contributions to Mercury releases to the atmosphere:

- Controlled landfills/deposits (26 Kg/y)
- Incineration of medical waste (21 Kg/y)
- Manometers and gauges with Mercury (19 Kg/y)
- Mineral oils-extraction, refining and use (16 Kg/y)

Source category	Source present (Y/N/?)	Calculated Mercury input to society	Calculated Mercury output, Kg/y					
			Air	Water	Land	By-products and impurities	General Waste	Sector-specific treatment/disposal
Extraction and use of fuels/energy sources								
Coal combustion in power plants	N	0	0	0	0	0	0	0
Coal combustion in coal fired industrial boilers	N	0	0	0	0	0	0	0
Other coal use	N	0	0	0	0	0	0	0
Mineral oils - extraction, refining and use	Y	54	16	33	0	0	0	5
Natural gas - extraction, refining and use	Y	1	1	0	0	0	0	0
Other fossil fuels - extraction and use	N	0	0	0	0	0	0	0
Biomass fired power and heat production	N	0	0	0	0	0	0	0
Geothermal power production	N	0	0	0	0	0	0	0
Primary (virgin) metal production								
Mercury (primary) extraction and initial processing (a)	N	0	0	0	0	0	0	0
Gold (and silver) extraction with Mercury amalgamation processes	N	0	0	0	0	0	0	0
Zinc extraction and initial processing	N	0	0	0	0	0	0	0

Copper extraction and initial processing	N	0	0	0	0	0	0	0
Lead extraction and initial processing	N	0	0	0	0	0	0	0
Gold extraction and initial processing by methods other than Mercury amalgamation	N	0	0	0	0	0	0	0
Aluminum extraction and initial processing	N	0	0	0	0	0	0	0
Other non-ferrous metals - extraction and processing	N	0	0	0	0	0	0	0
Primary ferrous metal production	hot spot (chromate mining)	0	0	0	0	0	0	0
Production of other minerals and materials with Mercury impurities								
Cement clinker production	Y	0	0	0	0	0	0	0
Pulp and paper production	N	0	0	0	0	0	0	0
Production of lime and light weight aggregates	N	0	0	0	0	0	0	0
Intentional use of Mercury in industrial processes								
Chlor-alkali production with Mercury-technology	N	0	0	0	0	0	0	0
VCM production with Mercury catalyst	N	0	0	0	0	0	0	0
Acetaldehyde production with Mercury catalyst	N	0	0	0	0	0	0	0
Other production of chemicals and polymers with Mercury	N	0	0	0	0	0	0	0
Consumer products with intentional use of Mercury								
Thermometers with Mercury	Y	0	0	0	0	-	0	0
Electrical switches and relays with Mercury	Y	0	0	0	0	-	0	0
Light sources with Mercury	Y	0	0	0	0	-	0	0
Batteries with Mercury	N	0	0	0	0	-	0	0
Polyurethane with Mercury catalysts	N	0	0	0	0	-	0	0
Biocides and pesticides with Mercury	N	0	0	0	0	-	0	0
Paints with Mercury	N	0	0	0	0	-	0	0
Pharmaceuticals for human and veterinary uses	N	0	0	0	0	-	0	0

Cosmetics and related products with Mercury	N	0	0	0	0	-	0	0
Other intentional product/process use								
Dental Mercury-amalgam fillings (b)	Y	2	0	0	0	0	1	1
Manometers and gauges with Mercury	Y	190	19	57	0	0	57	57
Laboratory chemicals and equipment with Mercury	Y	226	0	75	0	0	75	77
Mercury metal use in religious rituals and folklore medicine	N	0	0	0	0	0	0	0
Miscellaneous product uses, Mercury metal uses, and other sources	N	0	0	0	0	0	0	0
Production of recycled metals ("secondary" metal production)								
Production of recycled Mercury ("secondary production")	N	0	0	0	0	0	0	0
Production of recycled ferrous metals (iron and steel)	Y	2	1	0	1	0	1	0
Production of other recycled metals	Y	0	0	0	0	0	0	0
Waste incineration*3								
Incineration of municipal/general waste	N	0	0	0	0	0	0	0
Incineration of hazardous waste	N	0	0	0	0	0	0	0
Incineration of medical waste	Y	42	21	0	0	0	0	21
Sewage sludge incineration	N	0	0	0	0	0	0	0
Informal waste burning	N	0	0	0	0	0	0	0
Waste deposition/landfilling and wastewater treatment								
Controlled landfills/deposits*3	Y	26	26	0	0	0	0	0
Diffuse disposal under some control	N	0	-	-	-	-	-	-
Informal local disposal of industrial production waste	N	0	0	0	0	-	-	-
Informal dumping of general waste*1*3	N	0	0	0	0	-	-	-
Wastewater system/treatment*2	Y	452	0	226	0	0	135	90

Crematoria and cemeteries								
Crematoria/cremation	Y	0	0	0	0	-	0	0
Cemeteries	N	0	0	0	0	-	0	0
		934	83	165	1	0.27	269	252

Table 2.23 Summary of Mercury releases (overleaf)

* Notes to Table 2.23: (a) and (b): See note in the relevant sheets. *1: The estimated quantities include mercury in products, which has also been accounted for under each source category. To avoid double counting, the release to land from informal dumping of general waste has been subtracted automatically in the TOTALS. *2: The estimated release to water includes mercury amounts, which have also been accounted for under each source category. To avoid double counting, releases to the water from the wastewater system/treatment have been subtracted automatically in the TOTALS. *3: To avoid double counting mercury inputs from waste and products in the input TOTAL, only 10% of the mercury input to waste incineration sources, waste deposition and informal dumping is included in the total for mercury input. These 10% represent approximately the mercury input to waste from materials not quantified individually in Inventory Level 1 of this Toolkit. *4 To avoid double counting mercury in products produced domestically and sold on the domestic market (including oil and gas), only the part of mercury inputs released from production are included in the input TOTAL.



2.2.10 Results of the national Mercury inventory from emission

Based on 2022 Mercury inventory data, the MIA demonstrated that Oman has a total Mercury output of 770 Kg/y (~ 0.8 ton annually) (Table 2.24 & Table 2.25). The primary sources of Mercury emissions and releases is other intentional products/processes (principally manometers and gauges with Mercury and use and disposal of medical blood pressure gauges) and waste deposition/landfilling and wastewater treatment accounting for 54 and 33%, respectively of the total calculated Mercury outputs (Tables 2.24). The corresponding Mercury amounts for these sources are 419 Kg/y from other intentional product/process use, and 478 kg/y from waste deposition/landfilling and wastewater treatment (Table 2.25).

As illustrated in Tables 2.24 and 2.25, the following individual Mercury sub-categories made the most significant contributions to Mercury emissions into the atmosphere (in descending order):

- Controlled landfills/deposits (25.8 Kg/y)
- Incineration of medical waste (21.2 Kg /y)
- Manometers and gauges with Mercury (19.0 Kg/y)
- Mineral oils-extraction, refining and use (15.8 Kg/y)

Source category	Calculated Mercury output, Kg/y							
	Air	Water	Land	By-products and impurities	General waste	Sector-specific treatment / disposal	Total releases by source category	Percentage (%) of total releases*3*4
Extraction and use of fuels/energy sources	16.6	33.2	-	-	-	5.5	55	7
Primary (virgin) metal production	-	-	-	-	-	-	-	0
Production of other minerals and materials with Mercury impurities*1	0.0	-	-	0.0	-	0.0	0	0
Intentional use of Mercury in industrial processes	-	-	-	-	-	-	-	0
Other intentional product/process use*2	19.0	132.0	-	0.2	132.6	134.8	419	54
Production of recycled metals	0.7	-	0.7	-	0.7	-	2	0
Waste incineration and burning	21.2	-	-	-	-	21.2	42	5
Waste deposition/landfilling and wastewater treatment*3*4	25.8	226.0	-	-	135.5	90.3	478	33
Crematoria and cemeteries	0.1	-	-	-	-	-	0	0
Battery with Mercury production	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SUM OF QUANTIFIED RELEASES*3*4	83	165	1	0	269	252	770	100

Table 2.24 Summary of total estimated Mercury emissions and releases in Oman for 2022

Source category	Estimated Mercury input, Kg/y	Calculated Mercury releases, Kg/y					
		Air	Water	Land	By-pro-ducts and impurities	General waste	Sector-specific treatment / disposal
Extraction and use of fuels/energy sources							
Mineral oils - extraction, refining and use	54.4	15.8	33.2	0.0	0.0	0.0	5.5
Natural gas - extraction, refining and use	0.7	0.8	0.0	0.0	0.0	0.0	0.0
Production of other minerals and materials with Mercury impurities							
Cement clinker production	0.1	0.02	0.0	0.0	0.05	0.0	0.02
Other intentional product/process use							
Dental Mercury-amalgam fillings	2.4	0.0	0.3	0.0	0.2	1.0	0.9
Manometers and gauges with Mercury	189.8	19.0	56.9	0.0	0.0	56.9	56.9
Laboratory chemicals and equipment with Mercury	226.4	0.0	74.7	0.0	0.0	74.7	77.0
Production of recycled metals ("secondary" metal production)							
Production of recycled ferrous metals (iron and steel)	2.0	0.7	0.0	0.8	0.0	1.0	0.0
Waste incineration*3							
Incineration of medical waste	42.4	21.2	0.0	0.0	0.0	0.0	21.2
Waste deposition/landfilling and wastewater treatment							
Controlled landfills/deposits*3	26.1	25.8	0.3	0.0	0.0	0.0	0.0
Wastewater system/treatment*2	451.5	0.0	225.8	0.0	0.0	135.5	90.3
Crematoria and cemeteries							
Crematoria/cremation	0.1	0.1	0.0	0.0	0.0	0.0	0.0
SUM OF QUANTIFIED RELEASES*3*4	934.3	83.3	165.4	1.0	0.3	269.1	251.8

Table 2.25 Summary of total estimated Mercury inputs in Oman for 2022

* Notes to Table 2.22-2.25: The estimated release to water includes Mercury amounts, which have also been accounted for under each source category. To avoid double counting, releases to water from the wastewater system/treatment have been subtracted automatically in the TOTALS. *3: To avoid double counting Mercury inputs from waste and products in the input TOTAL, only 10% of the Mercury input to waste incineration sources, waste deposition, and informal dumping is included. *4 To avoid double counting Mercury in products produced domestically and sold on the domestic market (including oil and gas), only the part of Mercury inputs released from production is included in the input TOTAL.

A. Amount of Mercury emitted into air

In Oman, the total Mercury emitted into the atmosphere was 83.3 Kg in 2022. Figure 2.1 shows the primary sources for Mercury emission into the air with descending contributions of controlled landfills/deposits (25.8 Kg/y), incineration of medical waste (21.2 Kg/y), releases from other products or process uses (i.e., Mercury-based manometers and gauges) (19.0 Kg/y) and discharge from crude oil and natural gas extraction, refining and use (16.6 Kg/y) (Table 1.2). Contribution of the identified sources does not vary much based on the calculated mean of their estimated Mercury amount (20.7 ± 4.0 Kg/y). More efforts should be coordinated between the concerned stakeholders to minimize the future Mercury emission to the atmosphere.

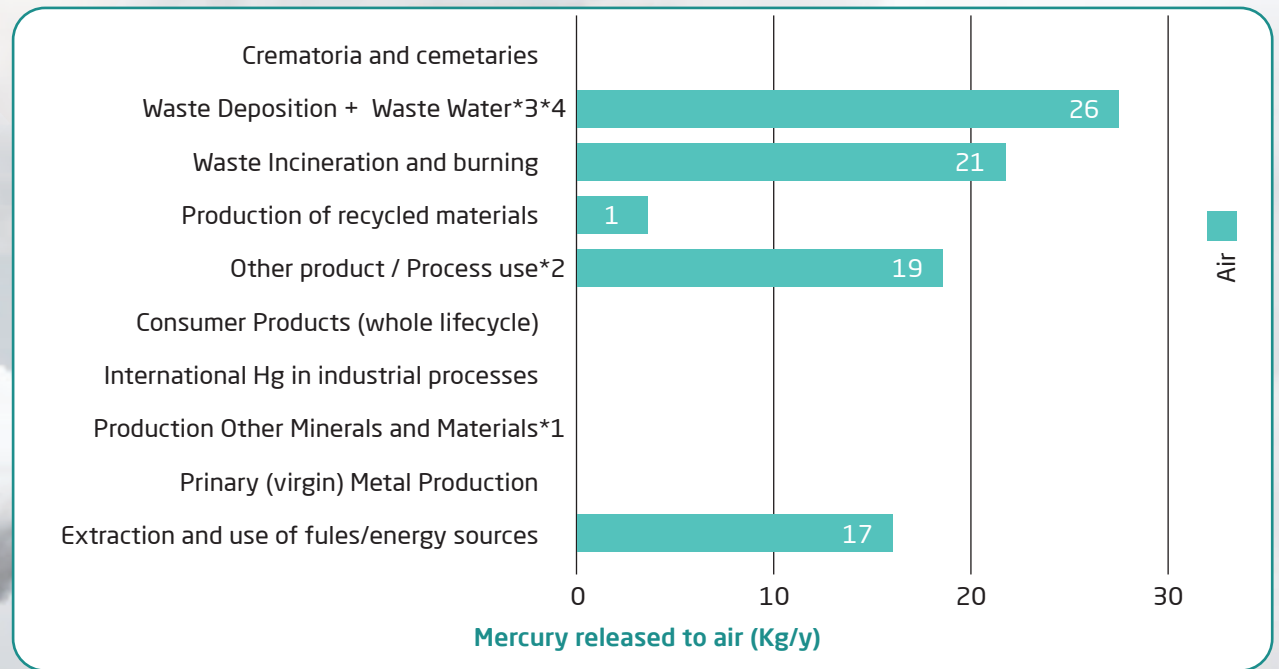


Figure 2.1: Estimated Mercury emissions into air in Oman⁴

B. Amount of Mercury released to water

Water systems in Oman receive almost twice the amount of Mercury emitted into the air. Mercury-containing effluents dumped into aquatic bodies, indirectly about 165 Kg of Mercury. Activities of oil extraction, refining and use, and disposal from hospitals and laboratories (mainly releases from Laboratory chemicals and equipment, including Mercury-based manometers and gauges) are important identified sources for discharge of Mercury-contaminated effluents into water (Figure 1.2 and Table 2.1). It is estimated that the wastewater system/treatment supplied most of the Mercury into the water (226 Kg, Figure 2.2). Nonetheless, this amount is excluded from the total Mercury releases to the water to avoid double-counting Mercury releases already incorporated in other source types (general and sector-specific waste/treatment).

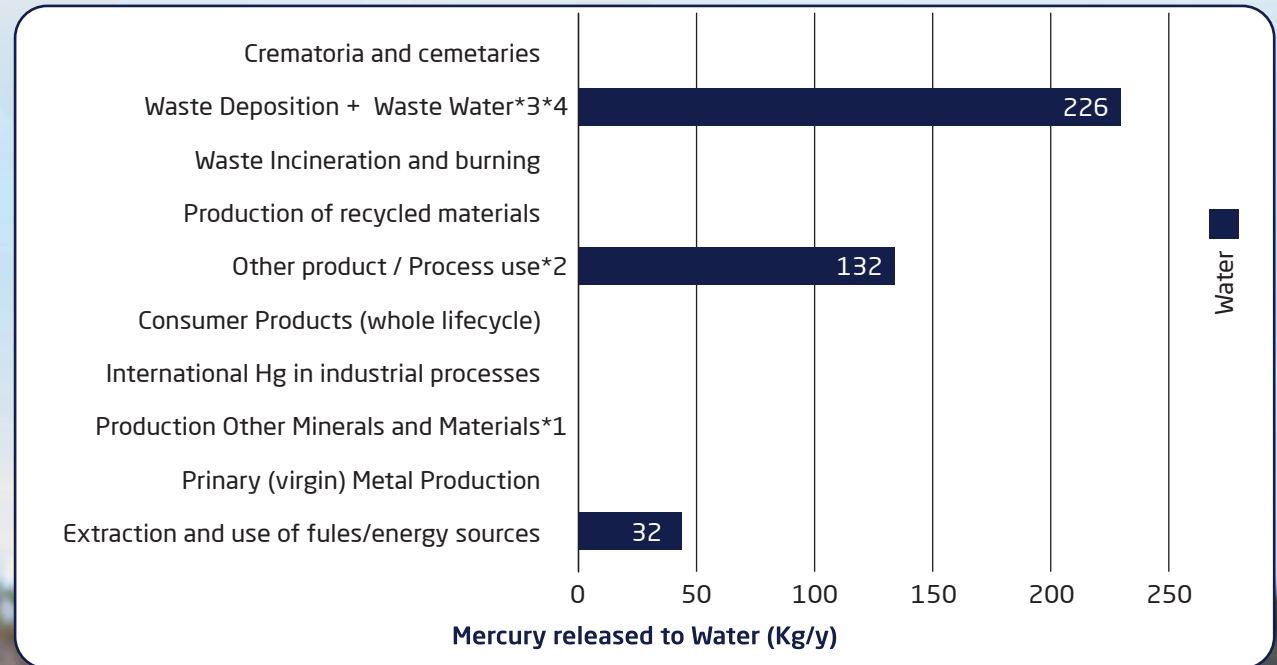


Figure 2.2: Estimated Mercury releases to water in Oman⁴



C. Amount of Mercury released to land

Overall, a negligible amount of Mercury (~ 1 Kg, Figure 2.3) is released to soils relative to the estimated amounts emitted and released into air and water (Figures 2.1 and 2.2). Based on the 2022 inventory data for Oman, the production of recycled ferrous metals (iron and steel) is likely responsible for generating this amount.

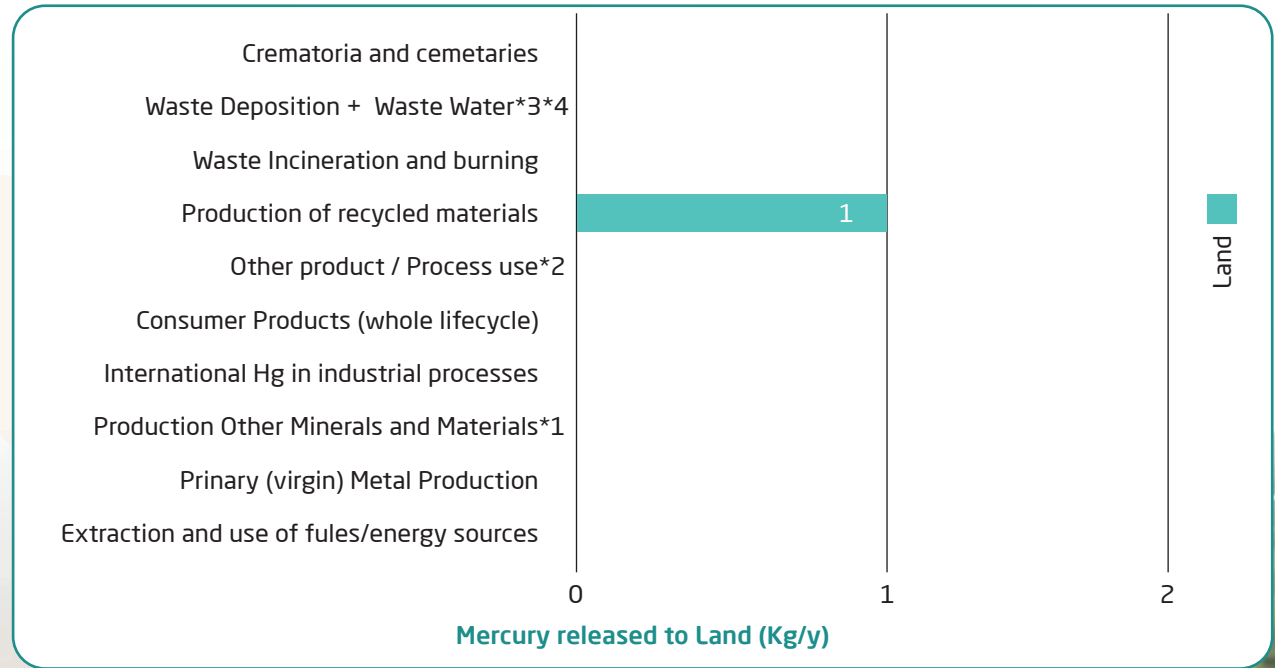
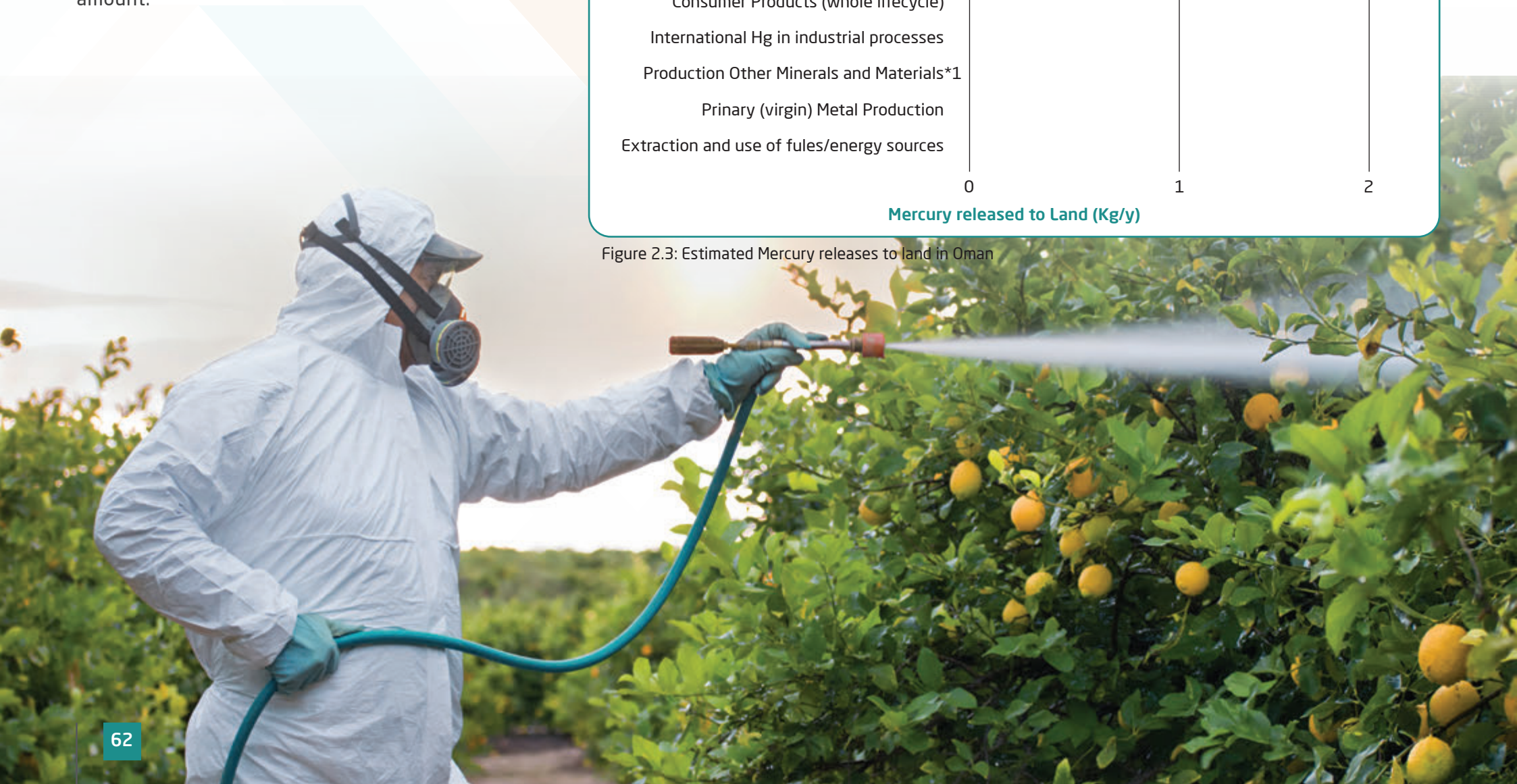


Figure 2.3: Estimated Mercury releases to land in Oman



D. Estimated Mercury outputs to by-products and impurities

Besides the Mercury outputs to the main environmental matrices (i.e., air, water, and land), by-products and impurities are an additional output pathway. These refer to Mercury, which flows back into the market as by-products and products, but Mercury does not play an intentional role. Neglected Mercury quantity (less than 0.5 Kg, Figure 2.4) was projected as Mercury by-products and impurities.

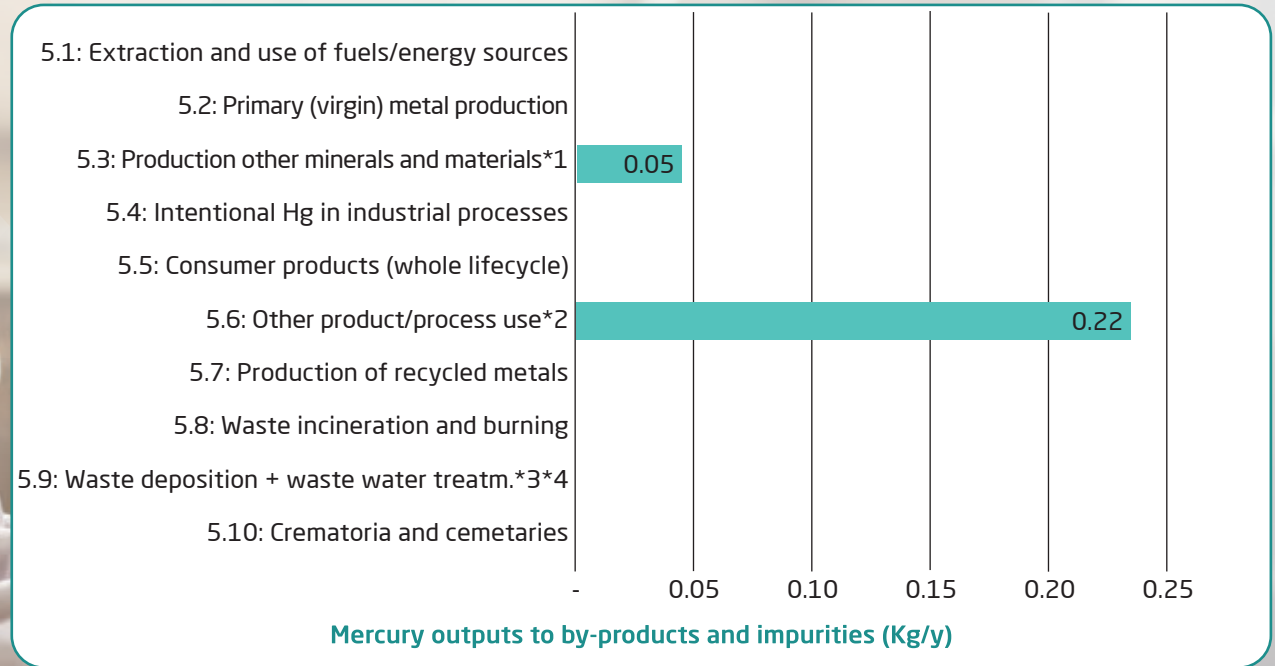


Figure 2.4: Estimated Mercury outputs to by-products and impurities in Oman⁵

E. Estimated Mercury outputs to general waste

The inventory identified Mercury releases to the general waste as the most significant, with a total of 269 Kg/y and accounted for ~ 35% of the estimated Mercury releases in Oman in 2022 (Figure 2.5). With wastewater system/treatment (activated sludge treatment with 135.5 Kg/y), other products/processes (133 Kg/Y), production of recycled ferrous metals (iron and steel of recycled vehicles with < 1 Kg/y) were found to be the contributors to the general waste category.

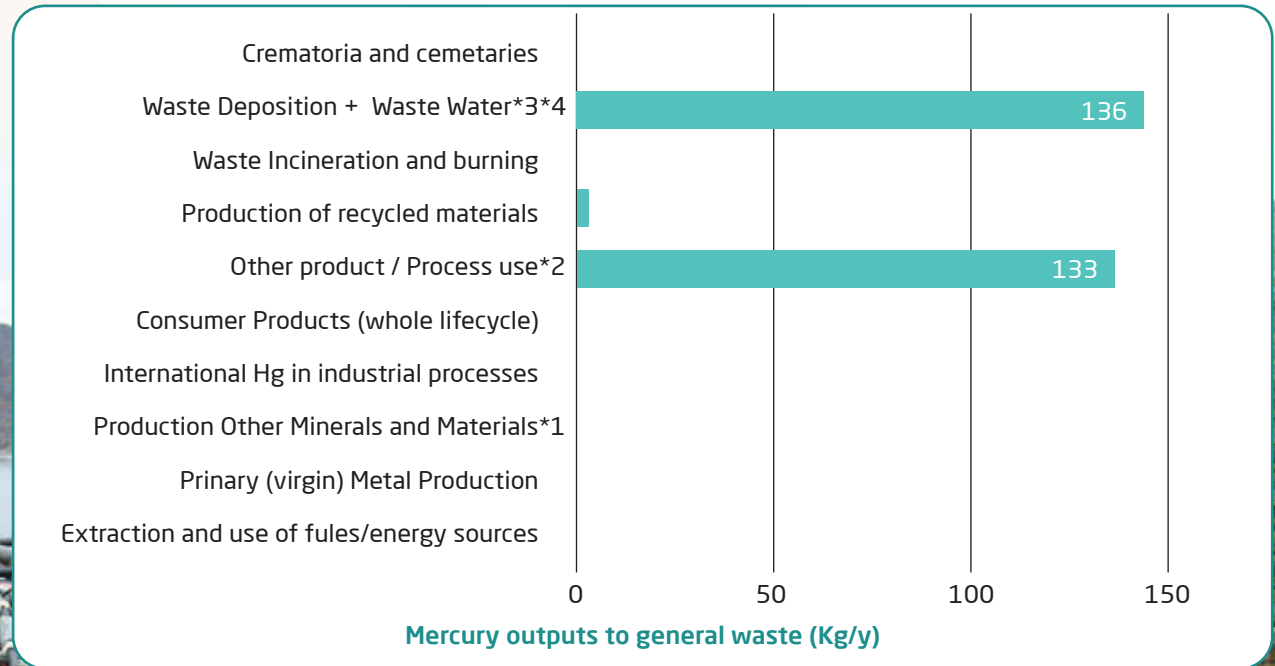


Figure 2.5: Estimated Mercury outputs to general waste in Oman

F. Estimated Mercury outputs to sector specific waste/treatment

Next to Mercury outputs to sector, specific waste/treatment represented about 32.7% (252 Kg/y, Figure 2.6) of the overall Mercury outputs in Oman. In 2022, the contributors were wastewater system/treatment (90.3 Kg), incineration of medical waste (21.2 Kg), and refining processes of mineral oils (5.5 Kg)

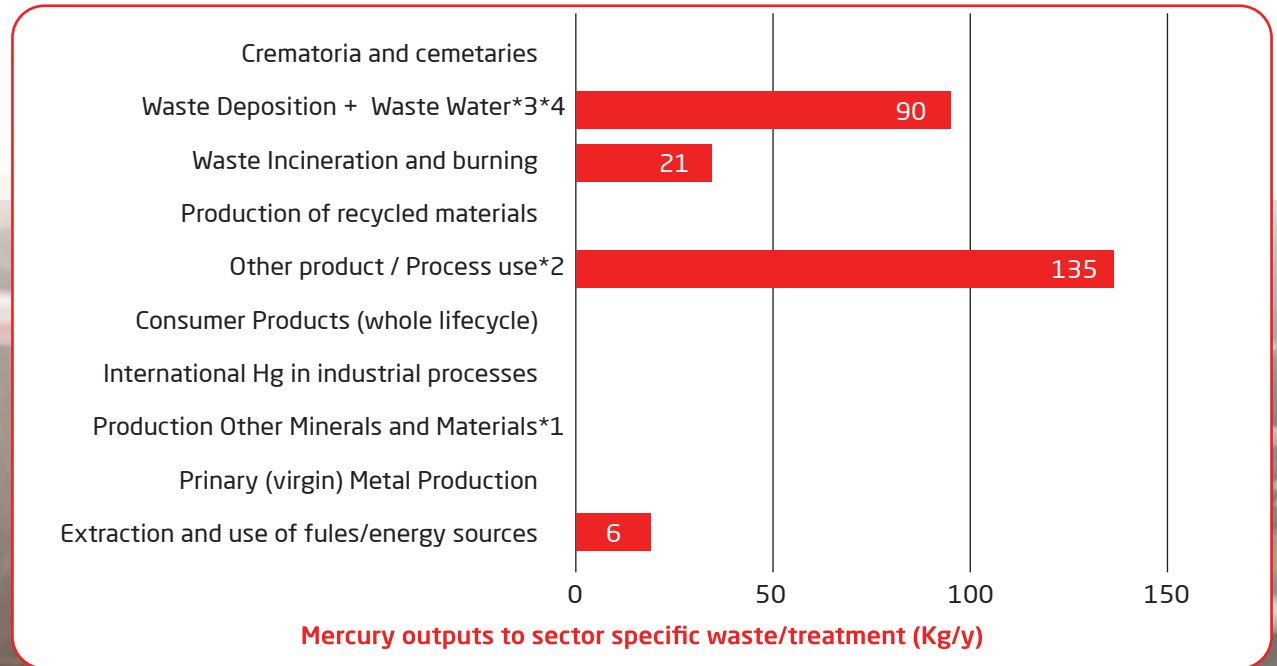


Figure 2.6: Estimated Mercury outputs to sector specific waste/treatment in Oman



G. Mercury inputs to society

Table 2.26 presents the Mercury inputs to society, which should be understood here as the Mercury amounts made available for potential releases through economic activity in the country. This includes Mercury intentionally used in thermometers, blood pressure gauges, fluorescent light bulbs, etc. It also includes Mercury mobilised via extraction and use of raw materials containing Mercury in trace concentrations. For waste categories, the «inputs» are calculated to show the distribution of Mercury in waste through the different waste treatment activities and calculate releases from these activities. However, waste is not a source of Mercury input into society (except for waste import). Waste «inputs» are marked in italics.

Source category	Source present (Y/N/?)	Activity rate	Unit	Estimated Mercury input, Kg/y, per life cycle phase (as relevant)		
				Production	Use	Disposal
Extraction and use of fuels/energy sources						
Mineral oils - extraction, refining and use						
Extraction	Y	48,242,087	Oil, t/y	164	0	0
Refining	Y	10,701,586	Oil, t/y	36	0	0
Transportation and other uses than residential heating and other oil combustion facilities	Y	3,357,824	Oil, t/y	0	7	0
Other oil combustion facilities	Y	201,885	Oil, t/y	0	0	0
Natural gas - extraction, refining and use						
Extraction and refining	Y	47,581	Gas, Nm3/y	0	0	0
Use of raw or pre-cleaned gas	Y	7,770,368	Gas, Nm3/y	0	1	0
Primary (virgin) metal production						
Gold (and silver) extraction with Mercury amalgamation processes	?	0	Gold produced, kg/y	0	0	0
Copper extraction and initial processing						
Mining and concentrating	?	0	Concentrate used, t/y	0	0	0
Production of copper from concentrates	?	0	Concentrate used, t/y	0	0	0
Gold extraction and initial processing by methods other than Mercury amalgamation	?	0	Gold ore used, t/y	0	0	0
Primary ferrous metal production	?	0	Pig iron produced, t/y	0	0	0

Production of other minerals and materials with Mercury impurities*1						
Cement clinker production						
Without co-incineration of waste	Y	-	Cement produced from nationally produced clinker (total, t/y)	0	0	0
Fossil fuel use in production (natural gas)	Y	4,509,289	Cement produced with this fuel as primary fuel, t/y (b)	0.0902	0	0
Production of lime and light weight aggregates						
Lime production	?	0	-	0	0	0
Consumer products with intentional use of Mercury						
Thermometers with Mercury						
Use and disposal (no disposal)	Y	94,147.282	Kg (Total)	0	0	0
Other glass Mercury thermometers	Y	0	-	0	0	0
Electrical switches and relays with Mercury						
Use and disposal	Y	4,436,897.08	Inhabitants	0	621	
Light sources with Mercury						
Fluorescent tubes (double end)	Y	22,902.393	Kg (Total)	0		0
Compact fluorescent lamp (CFL single end)	Y					
High pressure Mercury vapor	Y					
High-pressure sodium lamps	Y					
UV light for tanning	Y					
Metal halide lamps	Y					
Batteries with Mercury						
Mercury oxide (all sizes); also called Mercury-zinc cells	Y	16,113	Batteries, t/y	0	0	
Other intentional product/process use*2						
Dental Mercury-amalgam fillings						

Use - from fillings in the mouth (releases from Mercury supply for fillings 5-15 years ago)	Y	12.643	Kg Mercury/y	0	0	0
Disposal (releases from Mercury supply for fillings 10-20 years ago)	Y	3.684	Kg Mercury/y	0	0	0
Manometers and gauges with Mercury						
Use & disposal of medical blood pressure gauges	Y	2,372	Items/y	0		190
Laboratory chemicals and equipment with Mercury						
Laboratory chemicals	Y	4,527,446	Inhabitants	0		45.27
Other laboratory equipment (level 1 default for group)	Y	4,527,446	Inhabitants	0		181.10
Production of recycled metals ("secondary" metal production)						
Production of recycled ferrous metals (iron and steel)	Y	1,800	Vehicles recycled, Kg/y	1.98	0	0
Production of other recycled metals	Y	530,900	t/y	0	0	0
Waste incineration						
Incineration of medical waste	Y	1,765.5392	Waste incinerated, t/y	0	0	42
Waste deposition/landfilling and wastewater treatment*3*4						
Controlled landfills/deposits	Y	2,583,824.44	Waste landfilled, t/y	0	0	0
Wastewater system/treatment	Y	86,007,518	Wastewater, m3/y	0	0	452
Crematoria and cemeteries						
Crematoria/cremation	Y	24	Corpses cremated/y	0	0	0.096

* Notes to Table 2.21- 2.26 : Production phase includes raw material production. *2: The estimated release to water includes Mercury amounts, which have also been accounted for under each source category. To avoid double counting, releases to water from the wastewater system/treatment have been subtracted automatically in the TOTALS. *3: To avoid double counting Mercury inputs from waste and products in the input TOTAL, only 10% of the Mercury input to waste incineration sources, waste deposition, and informal dumping is included. *4 To avoid double counting Mercury in products produced domestically and sold on the domestic market (including oil and gas), only the part of Mercury inputs released from production is included in the input TOTAL. Waste <inputs> marked in italics are not a source of Mercury input into society (except in the case of waste import).

Note that the following source sub-categories made the largest contributions to Mercury inputs

to society:

- Electrical switches and relays with Mercury (621 Kg/y)
- Extraction and refining mineral oils (200 Kg/y)
- Use and disposal of medical blood pressure gauges (190 Kg/y)
- Other laboratory equipment (181.1 Kg/y)

The origin of Mercury in waste and wastewater produced in Oman is from products and materials. Waste fractions and wastewater do not represent the original Mercury inputs to society (except imported waste). Waste and wastewater may, however, represent substantial flows of Mercury through society. The following were found to be the significant flows of Mercury with waste and wastewater:

- Wastewater system/treatment (451.5 Kg/y)

2.2.11 Standard Taken for Calculation

In this subsection, various standards for analysis and results are presented. Table 2.27 describes the standardization used to calculate the permissible limits for estimating Mercury contamination in Oman.

Calculation result type	Description	Oman Guidelines
Estimated Mercury input, Kg Mercury/y	The standard estimate of the amount of Mercury entering this source category with input materials. For example, the calculated Mercury amount is the oil or natural gas used annually in the country for combustion in large power plants.	-
Air	<p>Mercury emissions to the atmosphere from point sources and diffuse sources from which Mercury may be spread locally or over long distances with air masses, for example, from:</p> <ul style="list-style-type: none"> • Point sources include natural gas-fired power plants (use or pre-cleaned), metal smelters, and waste incineration. • Refining and use of mineral oils. • Diffuse sources include small, informally burned waste lit by fluorescent lamps, bat-teries, Mercury-containing thermometers, medical blood pressure gauges, electrical switches, and relays. • Production of other minerals and materials with Mercury impurities (cement clinker) 	0.03 mg/m ³
Water	<p>Mercury releases aquatic environments and to wastewater systems: point sources and diffuse sources from which Mercury will be spread to marine environments (oceans), and freshwaters (rivers, lakes, etc.). For example, releases from:</p> <ul style="list-style-type: none"> • Wastewater/effluent from the extraction and refining of mineral oils. • Industry, households, etc., to aquatic environments. • Wastewater/effluent from the use and disposal of old Mercury-containing dental fillings. Wastewater/effluent associated with using and disposing of medical blood pressure gauges, laboratory chemicals, and equipment with Mercury. • Waste deposition/landfilling and wastewater treatment 	≤0.1 mg/L
Land	<p>Mercury is released to the soil and the terrestrial environment, which includes general soil and groundwater. For example, releases from:</p> <ul style="list-style-type: none"> • Uncollected waste products are dumped or buried informally. • Local unconfined releases from industry include on-site hazardous waste stor-age/burial. • Spreading of sewage sludge with Mercury content on agricultural land (sludge used as fertilizer). • Production of recycled ferrous metals (iron and steel) 	150 mg/Kg

By-products and impurities	<p>By-products that contain Mercury, which are sent back into the market and cannot be directly allocated to environmental releases, for example:</p> <ul style="list-style-type: none"> • Sulphuric acid is produced from desulphurizing flue gas (flue gas cleaning) in non-ferrous metal plants with Mercury-trace concentrations. • Use of natural resources in the production of cement clinker 	-
General waste	<p>General waste: also called municipal waste in some countries. Typically, household and institutional waste is treated in general ways, such as incineration, landfilling, informal dumping, or burning. The Mercury sources of waste are consumer products with intentional Mercury content (batteries, thermometers, fluorescent tubes, etc.) and high volume waste like printed paper, plastic, etc., with small trace concentrations of Mercury. These may</p>	≤0.1 mg/L
Sector-specific waste treatment /disposal	<p>Waste from industry and consumers, which is collected and treated in separate systems, and in some cases recycled, for example:</p> <ul style="list-style-type: none"> • Refining of mineral oils. • Natural gas is used in the production of cement clinkers. • Hazardous industrial waste with high Mercury content is deposited in dedicated, safe sites. Hazardous consumer waste with Mercury content, mainly separately collected and safely treated batteries, thermometers, Mercury switches, lost teeth with amalgam fillings, etc. Country-specific waste treatment/disposal method is described for each sub-category in the detailed report sections below (e.g., incineration of medical waste, wastewater system/treatment) 	≤0.001 mg/L

Table 2.27 Description of the types of Mercury outputs relevant to Oman

2.3 Identified Mercury contaminated sites in Oman

The published national inventory in 2022 did not reveal any Mercury-contaminated sites in Oman. However, Table 2.28 defines a few potential Mercury hot-spots sites probably for direct Mercury releases during the related activities processes, as well as a lack of adequate disposal of Mercury-contaminated by-products and/or wastes. Nevertheless, the identified hot spots may still have the potential to release amounts of Mercury, which could pose a risk to human health and the environment. The central locations are the Nakhal, Smail, Al-Mutaibhi, Sohar, Izki, Al-Awabi, Muhza, Al-Qabil, Al-Mutaibhi, Wadi Mawil, Zinik, Bidiya, Bidbid, Wadi Bani Khalid, Al-Suwaiq, Nizwa, Dama Watein, Ibra, Sanash, Oman-MDO, Oman-PDO, Oman grade chromite ores. Table 2.28 lists the potential Mercury hot-spot sites in Oman.

Site name	Location	Original source of Mercury contamination	Summary description	References
Contaminated stopped area	Nakhal	Literate (Steel)	Although the plant is fully stopped, it has been identified as a potential source of environmental releases of heavy metals, including literate.	Oman-EA
Contaminated stopped areas	Smail, Al-Mutaibhi, Sohar, Izki, Al-Awabi and Muhza	Chromium	Although the plant is fully stopped, it has been identified as a potential source of environmental releases of heavy metals, including chromium.	Oman-EA
Contaminated stopped area	Al-Qabil	Manganese	Although the plant is fully stopped, it has been identified as a potential source of environmental releases of heavy metals, including manganese.	Oman-EA
Contaminated- totally closed areas	Al-Mutaibhi, Izki, Smail, Nakhal, Wadi Mawil, Zinik, Bidiya, Bidbid, Sohar, Wadi Bani Khalid, Al- Suwaiq, Nizwa, Dama Watein and Ibra	Chromium	Although the plant is totally closed, it has been identified as a potential source of environmental releases of heavy metals, including chromium.	Oman-EA
Contaminated-totally closed area	Sanash	Copper	Although the plant is totally closed, it has been identified as a potential source of environmental releases of heavy metals, including copper.	Oman-EA

Contaminated-totally closed area	Al-Qabil	Manganese	Although the plant is totally closed, it has been identified as a potential source of environmental releases of heavy metals, including manganese.	Oman-EA
Contaminated area	Oman-MDO	Mercury could be released when chromate is extracted.	Although no studies have been conducted in Oman, metal mining has been identified as a potential source of environmental releases of heavy metals, including Mercury.	Li et al., 2014
Mercury	Oman-PDO	Mercury could be released from the non-protective means.	One of the most expensive waste products polluted with Mercury is sludge. Mercury must be stored in a specific location of a waste disposal facility in thick-gauge, labelled plastic bags.	PDO, 2022
Mercury	Oman grade chromite ores.	Mercury could be released from the non-protective means.	According to the Oman Chromite Company, Oman is home to about 30 million metric tons of chromite ore and exports metallurgical-grade chromite ores.	Jakimska et al., 2011

Table 2.28 Identification of potential Mercury hot spots in Oman



2.4 Summary

In Oman, Mercury is released through economic activity. This includes Mercury intentionally used in products such as thermometers, blood pressure gauges, fluorescent light bulbs, etc. It also includes Mercury mobilized via the extraction and use of raw materials, which contain Mercury in trace concentrations. In Oman, the major sources of Mercury contamination identified in the present study include the extraction and use of fuels and coal combustion in power plants.

The current Mercury inventory has not covered areas such as industrial processes using Mercury, medical devices other than thermometers, and domestic and industrial wastewater, which could be additional sources of Mercury contamination.

Unfortunately, in Oman, there is no structured mechanism for disposing of products containing a significant amount of Mercury.

Oman lacks appropriate Mercury-added products disposal mechanisms. There are a few hot spots. The central locations are the Nakhal, Smail, Al-Mutaibhi, Sohar, Izki, Al Awabi, Muhza, Al-Qabil, Al-Mutaibhi, Izki, Smail, Nakhal, Wadi Mawil, Zinik, Bidiya, Bidbid, Sohar, Wadi Bani Khalid, Al-Suwaiq, Nizwa, Dama Watein, Ibra, Sanash, Al-Qabil, Oman-MDO, Oman-PDO, Oman grade chromite ores. Table 2.28 lists the potential Mercury hot-spot sites in Oman. The metal production as a primary source of Mercury contamination, the Mercury releases from all specific sources of virgin metal production could be Mercury (primary) extraction and initial processing, (silver) extraction with Mercury amalgamation processes, zinc, lead, aluminium and copper extraction and initial processing mining and concentrating for the alumina production from bauxite and Primary ferrous metal production. The use of Mercury in industrial processes is another source of Mercury contamination; the amount of Mercury released through the use of Mercury in industrial processes was investigated.

The Mercury goes into the environment through industrial processes in two ways. It was calculated that output release from the uses of Manometers and gauges with Mercury is to air (18.98 Kg/t), water (56.93 Kg/t), sector-specific waste treatment (56.93 Kg/t), and general waste treatment (56.93 Kg/t). The calculated output released from the use of laboratory chemicals and equipment with Mercury is air (14.94 Kg/t), sector-specific waste treatment (15.39 Kg/t), and general waste treatment (14.94 Kg/t). The key Mercury releases from the use of other intentional products/ other laboratory equipment are to water (59.76 Kg/t), sector-specific waste treatment (61.57 Kg/t), and general waste treatment (59.76 Kg/t). It was found that the releases are water (0.33 Kg/t), land (0.34 Kg/t), and general waste treatment (0.33 Kg/t). The Mercury releases from all specific sources of waste incineration and burning is investigated with these sources (a) Incineration of municipal/general waste, (b) Incineration of hazardous waste, (c) Incineration of medical waste, (d) Sewage sludge incineration, and (e) Open waste burning on landfills and informally. The study found the key Mercury releases from the incineration of medical waste. It was found that the incineration of medical waste are releases to air and sector specific waste treatment. Air (21.19 Kg/t) and water (21.19 Kg/t) are calculated output releases. The water and land bodies remained unaffected. The computed output release is 225.77 mg/t, 135.46 Kg/t, and 90.31 Kg/t, respectively. The air and land bodies remained unaffected. The study found that the Mercury releases here are released to the air (the atmosphere), and the calculated output release is 0.10 units, and the water and land bodies remained unaffected.

Chapter 3: Policy, Regulatory, and Institutional Framework Assessment



3.1

Introduction

The toxic nature of Mercury is a global challenge that needs to be tackled using appropriate measures in the form of policies, laws, regulations, and a framework. Several countries have developed their regulations based on the needs of the local population and environmental conditions. Following the footsteps of developed countries, Oman has also designed and implemented policies and regulations to address the contamination of Mercury. The present study has investigated various policies and regulations regarding Mercury contamination in Oman. The Environment Authority has created policy guidelines for locating and evaluating Mercury-contaminated sites. Oman has established regulatory frameworks to control and handle the scheduled hazardous wastes, i.e., the waste that contains Mercury or its compounds, as a Party to the Basel Convention.



3.2 Ratification of Minamata Convention

Ratification of the Minamata Convention on Mercury binds the Sultanate of Oman legally to the Convention's obligations. As soon as Oman ratified the Convention and the Convention enters into forces, Oman entered into the implementation phase during which it has completed its Mercury Initial Assessment report (MIA) comprised of the completion of its national situation analysis of both the policy, regulatory and institutional framework assessment, Mercury inventory, population at risk and launched a national awareness addressing schools, universities, Oman chamber of industries and Commerce, civil society organizations, women and youth organizations. Moreover, Oman identified the legal and administrative actions to consider in the subsequent implementation phase.

After a lengthy debate and discussion lasting more than 15 years, the Convention became effective on 16 August 2017. One hundred and twenty-one countries have signed this Convention. The Convention has 35 articles covering various environmental aspects (e.g., Mercury sources, emissions to the atmosphere, releases to land and water, Mercury waste and Mercury-contaminated sites, etc.), manufacturing processes involving Mercury and its compounds, health aspects, and other administrative, supportive, and technical-related articles (e.g., financial, education, reporting, etc.). The signatory countries/states must implement their obligations under the Convention. These include, but are not limited to, controlling anthropogenic Mercury emission to the atmosphere and releases to the hydrosphere and lithosphere, phasing out and banning existing and future Mercury mines, respectively. Additionally, discontinuing and gradually reducing the use of Mercury and its compounds in some processes and products, unifying the national Mercury-related legislations to regulate gold mining, handling Mercury-containing waste/by-products, and addressing Mercury-contaminated and storage sites, and campaigning nationwide for raising public awareness of Mercury and its potential risks.

Nevertheless, the Convention's text highlights the flexibility to accommodate and allow national development plans since it requires the allocation of financial resources and technical support to achieve the overall national reduction of Mercury emissions and releases. The Minamata Convention on Mercury is closely related to other multilateral environmental conventions (Basel, Rotterdam, and Stockholm), sharing the common objective of protecting human health and the environment from hazardous substances and waste.

In Article 30, the following Environment Authority (EA) and royal decrees guidelines for the ratification, acceptance, approval, and accession are given below for the Mercury Minamata convention, as follows,

1. This Convention shall be subject to ratification, acceptance, or approval by States and regional economic integration organizations. It shall be open for accession by States and regional economic integration organizations from the day after the date on which the Convention is closed for signature. Instruments of ratification, acceptance, approval, or accession shall be deposited with the Depository.
2. Any regional economic integration organization that becomes a Party to this Convention without any member States being a Party shall be bound by all the obligations under the Convention. In the case of such organizations, one or more of whose member States is a Party to this Convention, the organization and its member States shall decide on their respective responsibilities for performing their obligations under the Convention. In such cases, the organization and the member States shall not be entitled to exercise rights under the Convention concurrently.

3. In its instrument of ratification, acceptance, approval, or accession, a regional economic integration organization shall declare the extent of its competence in respect of the matters governed by this Convention. Any such organization shall also inform the Depository, who shall notify the Parties, of any relevant modification of the extent of its competence.

4. Each State or regional economic integration organization is encouraged to transmit to the Secretariat information on its measures to implement the Convention at the time of its ratification, acceptance, approval, or accession to the Convention.

5. In its instrument of ratification, acceptance, approval or accession, any Party may declare that, regarding it, any amendment to an annex shall enter into force only upon the deposit of its instrument of ratification, acceptance, approval or accession.



3.3 Institutional and legislations policies and frameworks, on Mercury in Oman

The Sultanate of Oman will implement the Minamata Convention on Mercury through national ministries and other stakeholders. Moreover, these stakeholders also performed the assessments jointly in coordination with the relevant ministries, agencies, and private sectors. These were conducted as a prerequisite to capacity assessments during the MIA work, especially within the multi-sectoral task forces established during the assessment process and the report validation workshop. In addition to serving as the Convention's focal point and competent authority, the Environmental Authority is also in charge of various implementation tasks. Oman has identified the relevant ministries, agencies, and institutions as well as non-governmental organizations, private sector stakeholders, and others, along with their respective roles and responsibilities, to ensure the effective implementation of the Minamata Convention through coordinated actions from institutions and stakeholders.

The institutional capability deficiencies within these ministries and other stakeholders were also evaluated. Following the model established for legislative measures, the institutional capacity assessment is tabulated and includes identifying the relevant stakeholders for each article, considering the current capacity for implementing the appropriate article, and assessing the opportunity for capacity enhancement. Table 3.1 represents the ministries and stakeholders engaged in the Minamata Convention on Mercury implementation in Oman.



Source category	Data sources - Stakeholders
Extraction and use of fuels/energy sources	
Coal combustion in power plants	Ministry of Energy and Minerals
Coal combustion in coal-fired industrial boilers	
Other coal use	
Mineral oils - extraction, refining, and use	
Natural gas - extraction, refining, and use	
Other fossil fuels - extraction and use	
Biomass-fired power and heat production	
Geothermal power production	
Primary (virgin) metal production	
Mercury (primary) extraction and initial processing	Ministry of Energy and Minerals (Vale/ Jindal Companies)
Gold (and silver) extraction with Mercury amalgamation processes	
Zinc extraction and initial processing	
Copper extraction and initial processing	
Lead extraction and initial processing	
Gold extraction and initial processing by methods other than Mercury amalgamation	
Aluminum extraction and initial processing	
Other non-ferrous metals - extraction and processing	
Primary ferrous metal production	
Production of other minerals and materials with Mercury impurities	
Cement clinker production	Environment Authority
Pulp and paper production	
Production of lime and lightweight aggregates	
Intentional use of Mercury in industrial processes	

Chlor-alkali production with Mercury-technology	Environment Authority
VCM production with Mercury catalyst	
Acetaldehyde production with Mercury catalyst	
Other production of chemicals and polymers with Mercury	
Consumer products with the intentional use of Mercury	
Thermometers with Mercury	Ministry of Health, Bea'h Company, Ministry Agriculture, Fisheries and Water Resources, Ministry of Defense and Ministry of Higher Education, Research and Innovation
Electrical switches and relays with Mercury	Ministry of Health, Bea'h Company, Au-thority for Public Services Regulation
Light sources with Mercury	
Batteries with Mercury	
Polyurethane with Mercury catalysts	Ministry Agriculture, Fisheries and Water Resources
Biocides and pesticides with Mercury	
Paints with Mercury	Ministry of Commerce
Pharmaceuticals for human and veterinary uses	Ministry of Health, Bea'h Company, Authority for Public Services Regulation
Cosmetics and related products with Mercury	Ministry of Health, Ministry of commerce
Other intentional product/process use	
Dental Mercury-amalgam fillings (b	Ministry of Health, Ministry of Defense
Manometers and gauges with Mercury	Ministry of Health, Ministry of Defense, Ministry of Education
Laboratory chemicals and equipment with Mercury	Ministry of Health, Bea'h Company, Ministry of Higher Education, Research and Innovation, Ministry Agriculture, Fisheries and Water Resources, Ministry of Defense
Mercury metal use in religious rituals and folklore Medicine	Ministry of Health, Ministry of commerce
Miscellaneous product uses, Mercury metal uses, and other sources	Ministry of Health
Production of recycled metals ("secondary" metal production)	
Production of recycled Mercury ("secondary produc-tion")	Environment Authority / Ministry of commerce
Production of recycled ferrous metals (iron and steel)	
Production of other recycled metals	
Waste incineration*3	

Incineration of municipal/general waste	Bea'h Company / Environment Authority
Incineration of hazardous waste	
Incineration of medical waste	
Sewage sludge incineration	
Informal waste burning	
Waste deposition/landfilling and wastewater treatment	
Controlled landfills/deposits*3	Bea'h Company / Environment Authority
Diffuse disposal under some control	Environment Authority
Informal local disposal of industrial production waste	
Informal dumping of general waste*1*3	Bea'h Company/ Haya Wastewater Company/ Environment Authority
Wastewater system/treatment*2	
Crematoria and cemeteries	
Crematoria/cremation	Ministry of Interior (Municipalities)
Cemeteries	

Table 3.1 Stakeholders engaged in the Minamata Convention on Mercury implementation in Oman (Emission Sources in Oman 78- March 2022)

The government in Oman, through various departments, has established several guidelines and procedures in the form of legislation and articles for the sustainable use of Mercury and to control Mercury contamination. The main MIA Convention's articles corresponding to the legislation in Oman are as follows. Article 3.3, Article 3.4, Article 3.5 (a, b), Article 3.6, Article 4.1, Article 4.3, Article 4.5, Article 4.6, Article 5.2, Article 5.3, Article 5.4, Article 5.5, Article 5.7, Article 6.1, Article 7.2, Article 8.4, Article 8.5, Article 8.7, Article 9.3, Article 9.5, Article 9.6, Article 10.2, Article 11(a, b, c), Article 12.1, Article 12.2, Article 13.1, Article 13.2, Article 14.2, Article 16.1 (a, b, c), Article 17.1, Article 17.3, Article 17.5, Article 18.1, Article 18.2, Article 19.1, Article 19.2, Article 21.1, Article 21.2. Each of these articles is described in the following section.

3.3.1 Article 3: Mercury Supply Sources and Trade

The Environment Authority guideline chapter three (i.e., Protection of Environment) of Oil and Gas Law (8/2011) stipulates that “Without prejudice to the provisions of the laws relating to the protection of the environment in the Sultanate, the concessionaire shall be committed to conduct operations with due diligence and by the technical standards outlined in the concession agreement and international conventions to which the Sultanate is a party, to ensure the protection of the environment, and shall take all necessary measures to achieve this” As per Mineral Resources Law, “ore minerals and quarry materials are the property of the state, so no one can benefit from them unless an approval is obtained from the Ministry of Energy and Minerals”. This also applies to new primary Mercury mining, which is not allowed according to Article 3.3 of the Convention. Since there is no primary Mercury mining, legislation prohibiting future primary Mercury mining shall be developed.

Article number	Policy and regulatory measures in Oman	Gaps and Recommendation	Designated Authority
Article 3.3: Not to allow new primary Mercury mining	Under the Mineral Resources Law, ore minerals and quarry materials are the property of the state and require approval from the Ministry.	Gap: Legislation development for no primary Mercury mining. Recommendation: Development of the ASGM in Oman.	Ministry of Energy and Minerals
Article 3.4: Phase out existing primary Mercury mining within 15 years, to stop the import and use of Mercury from primary Mercury mining	This applies to new primary Mercury mining since there is no current primary Mercury mining, and legislation prohibits future primary Mercury mining.	Gap: Legislation development for no primary Mercury mining. Recommendation: Development of the relevant legislation.	Ministry of Energy and Minerals
Article 3.5(a): Obtain information on stocks of Mercury or Mercury compounds exceeding 50 metric tons (MT), and stocks exceeding 10 MT/year	Based on Article (12) and Article (8) of Royal Decree (46/95), “the user of hazardous chemicals, The Royal Decree stipulates that “License shall be obtained from the Directorate General of Civil Defense and R.O.P., for transporting and storing any hazardous chemical according to its Regulations issued in this respect.”	Gap: The legislation does not specify the required data, and no database for recording chemicals exists. Recommendation: Developing legislation or adding to the record of chemicals and their waste.	Environment Authority
Article 3.5(b): restrict the use of excess Mercury from decommissioning chlor-alkali plants, and require environmentally sound disposal	By Article (11) and Article (28) of Decision No. (17/2021) of Royal Decree 46/95, “the user of hazardous chemicals shall be committed to dispose of under the supervision of the Ministry in issuing the Controls Regulating the Environmental Permits. Article (31) restricted chemicals, without a permit.	Gap: The legislation does not specify industries that may not use Mercury and its disposal, chlorine and alkali industries do not use Mercury in their manufacturing. Recommendation: Developing legislation to measure and dispose of surplus quantities stored.	Environment Authority, and The Public Authority for Special Economic Zones and Free Zones

Table 3.2 Mercury Supply Sources and Trade

3.3.2 Article 4: Mercury-added products

Article 4 is related to Mercury-added products. Table 3.3 describes the decisions on the Consumer Protection Authority Decision No. 98/2020 regulating the circulation of some cosmetic products. Article 1 of this decision prohibits the trade of cosmetic products if they contain Mercury, except after obtaining the approval of the Ministry of Commerce and Industry; moreover, the procedures of the Ministry of Health regarding thermometers, blood pressure gauges, and topical antiseptics.

Article number	Policy and regulatory measures in Oman	Gaps and Recommendation	Designated Authority
Article 4.1: Not to allow the manufacture, import, and export of products	<ul style="list-style-type: none"> Based on the Ministerial decision No. (190/2021) In the Technical Regulation, no place is given for products except those conforming to standard specifications. Article 13 of Ministerial Decision No. 41/2012, which issues the Executive Regulations for the Pesticides Law, stipulates that pesticides can be imported, exported, and manufactured. 	<p>Gap: Currently, there are no specific provisions of legislation regulating.</p>	<p>The Ministry of Commerce, Industry and Investment Promotion, and the Ministry of Agriculture are concerned with pesticides.</p>
Article 4.3: Phase down the use of dental amalgam and Article 4.6: Discourage the manufacture and distribution of new Mercury product types	<ul style="list-style-type: none"> Based on the Ministerial decision No. (190/2021) Promotion on the Technical Regulation, no products are allowed to be placed on the market except those conforming to standard specifications. The procedures of the Ministry of Health on exemptions to use amalgam 	<p>Gap: We need provisions in legislation regulating dental amalgam.</p> <p>Recommendations: Develop legislation for the use of dental amalgam, specifying exceptions by the MoH. Set national objectives for prevention and health promotion. Promote research and development for Mercury-free materials in dental restoration and restrict dental amalgam.</p>	<p>The Ministry of Commerce, Industry and Investment Promotion and the Ministry of Health.</p>

Table 3.3 Article 4 Mercury-Added Products

3.3.3 Article 5 and 6: Manufacturing processes in which Mercury or Mercury compounds are used and Exemptions available to a party upon request

Article 5 relates to manufacturing processes in which Mercury or Mercury compounds are used. Table 3.4 clarifying the Royal decrees and based on Article (4) of Royal Decree (46/95), the Committee shall, based on recommendation of the Department, suspend the user from continuing his activities in manufacturing, importing, exporting transporting, storing, handling or using any chemical to avoid any hazard threatening public health and the environment. The Department shall notify the user and the concerned agency of the decision to suspend and the reasons for such a decision. Article 6 describes the exemptions available to a party upon request.

Article number	Policy and regulatory measures in Oman	Gaps and recommendation	Designated authority
Article 5.2, 5.3, 5.4, and 5.7: Not allow Mercury use, restrict use, not allow new facilities using Mercury produced polyurethane, and discourage new Mercury uses in industrial processes.	Based on Article (4) of Royal Decree (46/95), to suspend from continuing in manufacturing, importing, exporting, transporting, storing, handling, or using any chemical to avoid any hazard threatening public health and the environment.	Gap: New legislation is needed. Recommendation: Develop the legislation. Take measures to reduce the use of Mercury in lowering emissions, use fresh Mercury, and research Mercury-free processes.	Environment Authority
Article 5.5 Obtain information on Mercury compound; to control Mercury emissions into air, land, and water.	Ministerial Decision 41/2017 issued the Regulations for Ambient Air Quality. Ministerial Decision 118/2004 issued the Regulations for Controlling Air Pollutants Released from Stationary Sources. Ministerial Decisions 145/93 and 159/2005 issued the Regulations for Wastewater Reuse and Discharge and Liquid Waste into the Marine Environment.	Gap: Existing legislation is being updated to specify a standard for the concentrations of emissions and releases, but there is no database on Mercury. Recommendations: Develop legislation, take measures, identify facilities, and define standards for releases into the environment.	Environment Authority
Article 6.1 Regional economic integration for one or more exemptions.	Not applicable	Gap: Not applicable. Recommendation: Determine the required exemptions, clarify the reasons, and send them to the Convention.	Environment Authority

Table 3.4 Mercury Supply Sources and Trade

3.3.4 Article 8, 9, and 10: Emissions, releases to land and water, and interim storage of Mercury, other than Mercury waste

Table 3.5 presents Article 8, which mainly describes the emission limits for the BAT/BEP and ministerial decisions. Article 9 explains the release of Mercury to land and water. Article 10 talks about environmentally sound interim storage of Mercury other than waste Mercury.

Article number	Policy and regulatory in Oman	Gaps and recommendations	Designated authority
Article 8.4 and 8.5: environmental practices (BAT/BEP) associated emission limit values (ELVs) and non-ferrous metal smelting and roasting processes, waste incineration, cement production, to reduce Mercury emissions.	Ministerial Decision No. 41/2017 issuing "Regulations for Ambient Air Quality", and Ministerial Decision No. 118/2004 issuing "Regulations for Controlling Air Pollutants Released from Stationary Sources".	Gap: The legislation must be updated, as it does not specify the permitted emission concentrations. Recommendations: Develop legislation, take measures, control emissions, and limit the concentration of the mercury emission rate, considering the economic and technical feasibility and affordability of the measures.	Environment Authority
Article 8.7: monitoring/reporting and otherwise establish a Mercury emission.	The present Mercury Initial Assessment project.	Gap: The present Mercury Initial Assessment project. Recommendations: The inventory for the Mercury Initial Assessment project.	Environment Authority and relative entities
Article 9.3, 9.5, and 9.6: Require reporting in identifying significant sources of Mercury and maintaining an inventory of releases from the sources.	The present Mercury Initial Assessment project and Royal Decree No. 114/2001 issuing Law on Conservation of Environment and Prevention of Pollution.	Gap: New legislation is needed to prevent Mercury contamination in soil and water with release parameters. Recommendations: Develop legislation, take measures, control emissions, limit emission concentration, develop a national plan and goals setting out the measures, and train human resources in sampling, analysis, and evaluation.	Environment Authority and Ministry of Agriculture, Fisheries and Water Resource are concerned with the water resources
Article 10.2: Take measures to ensure environmentally safe guidelines.	<ul style="list-style-type: none"> Based on Article (12) of Royal Decree (46/95), "the user of hazardous chemicals shall prepare registers, indicating names of persons, chemicals, quantities, numbers, extent of hazard, and methods of handling. These shall be submitted to the staff of the Chemicals Department whenever requested." Thus, information on quantities may be obtained from the Chemicals Department registers. Article 8 of the same Royal Decree stipulates that "License shall be obtained, from the Directorate General of Civil Defense -R.O.P., for transporting or storing any hazardous chemical according to its Regulations issued in this respect. 	Gap: A new legislation is needed. Recommendations: Develop legislation, prepare requirements for Mercury storage, and develop guidelines for handling under the Basel Convention on the Control and Movement of Hazardous Wastes.	Environment Authority

Table 3.5 Article 8 Emissions, reporting in identifying significant sources of Mercury and measures for environmentally safe guidelines

3.3.5 Article 11, 12, 13, 14: Mercury wastes, contaminated site, financial resources, and capacity building

Article 11 represents Decision No. (17/2021) issuing the Controls Regulating the Environmental Permits in the Special Economic Zones and Free Zones has shown in the Table 3.6, which stipulates in Article 28 that the project shall register the hazardous substance used, manufactured or produced as waste, with the competent department and obtain the necessary permits to deal with them, as per the legally defined principles and controls and the Basel Convention procedures.

Article number	Policy and regulatory measures in Oman	Gaps and recommendation	Designated authority
<p>Article 11.3 (a), 11.3 (b), Parties shall take measures to manage Mercury wastes and disposal</p> <p>Article 11.3 (c): Require transport across international boundaries following with the Basel Convention, or if the Basel Convention does not apply, consistent with international rules, standards, and guide-lines.</p>	<p>Based on Article (12) of Royal Decree (46/95), the user of hazardous chemicals is required to dispose of empty containers and any substance in violation of the Law under the supervision of the Ministry. Regulations for the Management of Hazardous Waste issued by Ministerial Decision No. (18/93). Royal Decree No. 119/94 on the Sultanate of Oman on the Basel Convention. Royal Decree No. (76/91) issuing the Law of Civil Defense and its amendments to regulate technical requirements for hazardous substances, transport, and storage. Royal Decree No.46/2009 in connection with the management and operation of the Waste Sector by Oman Environmental Service Holding Company S.A.O.C (be'ah). Decision No. (17/2021) to control and regulate the environmental permits in special economic and free zones. Article 30 of the same Decision stipulates that importing or exporting any hazardous materials listed in the Basel Convention is prohibited, without obtaining a permit. Article 31 stipulates that the project shall not use or handle restricted chemicals without obtaining a permit from the competent department and as per the conditions and procedures specified by the Law. In case of failure to do so, the Authority may suspend the project from using or handling restricted chemicals.</p>	<p>Gap: New legislation is needed. Recommendation: Develop legislation, prepare requirements for Mercury storage, and develop guidelines for handling under the Basel Convention on the Control and Movement of Hazardous Wastes, safe disposal, transportation, and movement.</p>	<p>Environment Authority and Be'ah Company (regarding the proper storage and final disposal of waste of Mercury and its compounds)</p>

<p>Article 12.1 and 12.2: Develop strategies for identifying contaminated sites, risk reduction activities, and environmentally risk assessment strategies.</p>	<p>The present Mercury Initial Assessment project</p>	<p>Gap: Mercury Initial Assessment. Strategies and mechanisms for identifying and assessing polluted sites need to be determined through environmental impact assessment (EIA) studies. Recommendations: Develop an appropriate national implementation plan to identify and evaluate contaminated sites, reduce the risks posed by these sites, develop national capabilities to detect polluted sites, develop assessment methods, and conduct decontamination operations. The National Program for Monitoring Pollutants in the Marine Environment includes monitoring nutrient and pollutant levels, according to the standards recommended by the Regional Organization for the Protection of the Marine Environment, the United Nations Environment Program, and the World Health Organization.</p>	<p>Environment Authority</p>
<p>Article 13.1: Access domestic resources to implement Convention obligations. Article 13.2: Access financial resources under the Convention funding sources.</p>	<p>Not applicable</p>	<p>Gap: Not applicable Recommendation: Suggest programs and projects for the Global Environment Facility Trust Fund, including capacity-building and technical assistance, training programs, workshops, and involvement in the private sector.</p>	<p>Environment Authority</p>
<p>Article 14.2 Capacity-building and technical assistance according to national arrangements, including partnerships involving the private sector.</p>	<p>Not applicable</p>	<p>Gap: Not applicable Recommendations: Develop recommendations on capacity building, technical assistance, technology transfer, and promotion activities for the effective implementation of the Convention.</p>	<p>Environment Authority</p>

Table 3.6 Article 8 Emissions, reporting in identifying significant sources of Mercury and measures for environmentally safe guidelines

Furthermore, Article 16 is related to the health impact of Mercury. For instance, Article 16.1(a) promotes developing and implementing strategies to identify populations at risk in fish consumption. Article 16.1(b) Occupational exposure educational and prevention programs.

Article 16.1(c) Treatment and care services for affected populations. It is recommended that health guidelines be adopted, setting targets to reduce mercury exposure. Additionally, developing programs to strengthen institutional and professional health capacities to prevent, diagnose, treat, and monitor health risks, enhancing consultation, co-operation, and exchange of information with the World Health Organization, the International Labor Organization, and other relevant international organizations.

Moreover, Article 17 focuses on information exchange on the health and safety of humans and the environment; for example, Articles 17.1, 17.3, and 17.5 are the national focal points for information exchange under the Convention.

Awareness and education are mentioned in Article 18. Article 18.1 and 18.2: promote and facilitate provision to the public, education, training, and public awareness related to the effects of exposure to Mercury and Mercury compounds on human health and the environment. It is needed to be developing and implementing educational and prevention programs based on scientific facts related to health and environmental effects, promoting research, development and monitoring and management of Mercury, defining and approving research and development centers to monitoring environmental pollutants, creating a database of all stocks, uses, manufacturing processes, stock estimates, annual emissions and releases, and disposal methods. The research, development, and monitoring are mentioned in Article 19. For example. Article 19.1: endeavor to cooperate (a) Inventories, consumption, anthropogenic emissions (b) Modelling, geographically representative monitoring of levels of Mercury (c) Assessments, impact of Mercury on human health and environment; (d) Harmonized methodologies for the activities. Article 19.2 builds on existing monitoring networks. The National Program for Monitoring Pollutants in the Marine Environment includes monitoring nutrient and pollutant levels, chemical, physical, and biological characteristics, sediment, and vital indicators to detect any pollutants in all waters of the Sultanate, covering several sites in various governorates. Samples of sea water are also taken to study concentrations of hydrocarbons, heavy metals, nutrients, and harmful algae, which will then be analyzed according to the standards recommended by the Regional Organization for the Protection of the Marine Environment, the United Nations Environment Program, and the World Health Organization.

The recommendations include developing an appropriate national implementation plan to identify stocks, uses, manufacturing processes, estimates of stocks, emissions and releases, methods of disposal, assessment of social, economic, and cultural impacts, and research and information on the use of the best available technologies and best environmental practices to reduce emissions. Developing national capacities for preparing inventories, submissions, and their assessment, as well as carrying out studies on the effects of mercury levels on human health by taking hair samples.

While Article 21 talks about how to do reporting, for example, Article 21.1 reports to the conference, through the secretariat, to implement the provisions of this Convention, and on the effectiveness of such measures and the possible challenges in meeting the objectives of the Convention 21.1. Article 21.2 reports the information as called for in Articles 3, 5, 7, and 8.

The Recommendation includes commitment to submit annual reports to the Secretariat of the Basel Convention, preparing a program to follow up on the implementation of action plans, and adding a column to follow up on the implementation of the Convention according to the forms approved by the Convention.

3.4

Summary

In Oman, the importation of mercury and mercury compounds is restricted to license holders with a valid permit. Industries that release Mercury into the environment must perform frequent monitoring and submit the results to the Environment Authority. Manometers, barometers, sphygmomanometers, Mercury switches, Mercury relays, fluorescent lights, and other devices containing Mercury are among the products that Oman has taken the initiative to control. The Ministry of Health (MOH) has released a circular on purchasing, replacing, and disposing of these Mercury-carrying devices, which applies to all national hospitals, including Royal hospitals and Ministry of Defence Hospitals. In Oman, the lack of an appropriate legal framework to handle products containing proportional amounts of Mercury is one of the areas that policy and decision makers need to pay attention to.

Chapter 4: Identification of Population at Risk



4.1

Introduction

Mercury can cause adverse effects on both human and animal lives (Yang et al, 2020; Holmes et al., 2009). For instance, the human fetus, neonates, and young children (less than 12 years old) are particularly vulnerable to Mercury exposure. Moreover, people with a medical history of liver, renal, nervous system, or lung diseases are more susceptible to Mercury toxicity (Zulaikhah et al., 2020). Mercury toxicity affects the central and peripheral neurological systems. Mercury vapor inhalation affects the immunological, digestive, and kidney systems. If swallowed, the inorganic salts of Mercury can cause renal poisoning and damage to the digestive system. In addition, Mercury exposure causes tremors, sleeplessness, migraines, memory loss, neuromuscular effects, and cognitive and motor dysfunction (Goel et al., 2023).

Both men and women have similar side effects of Mercury toxicity. However, women are exposed to a higher amount of Mercury due to the presence of Mercury in cosmetics. Therefore, it is essential to develop gender specific policies and communication for training, education, and awareness strategies. This chapter focuses on exploring and identifying the Omani population affected by the Mercury contamination and further discussing the population at risk of Mercury toxicity. In Oman, the primary sources of Mercury toxicity to humans are the mining, dentists exposed to amalgam, workers involved in the waste incinerators, people eating the mercury-contaminated fish, and women using cosmetic products.

4.2 People affected by Mercury contamination

Mercury toxicity affects human populations and can lead to higher risks of immunological, cardiovascular, and neurological system failures. People affected by Mercury include those working in mines, experimental labs, amalgam, waste incinerators, eating fish contaminated with Mercury, and women using beauty products.

4.2.1 People working in mining sector

Oman holds deposits of dolomite, limestone, gypsum, silica, cobalt, marble, iron, and other minerals like copper, silver, chromite, lead, nickel, manganese, and zinc. In 2016, Salalah Port exported 8,576,415 tons of gypsum and limestone. It has been estimated that about 300 mining operations were operational as of December 31, 2016, among these 53 for chromite, 7 on copper, 108 on aggregate, 31 on marble, 25 on building products, 7 on limestone, 3 on sandstone and manganese, 5 on gypsum, laterite, and clay, and 1 on salt and dune sand.

The people who work in the mining sector are vulnerable to Mercury toxicity. In Oman, the mining operations are classified into five categories: mining for metal ore, metallic minerals, non-metallic minerals, quarrying, and mining support activities. Oman's natural mineral resources production was recorded as 17,665,556.200 metric tons in the first quarter of 2016, up from 91,966,872.800 metric tons in 2015 (Oman Mining Expo, 2018, and Audra, 2023). However, the mineral exploration activities significantly impacted occupational health and safety due to mining operations affecting the local populations and labor workforce.

Mercury is added to the ore to make an amalgam in the mining process. The amalgam is the source of Mercury toxicity for the workers. Since the amalgamation process is usually carried out by hand without personal protective equipment, the Mercury is absorbed through the skin, besides coming in contact with Mercury vapor (MOEM, 2023). After exposure to Mercury, Women in the mining sector return to their homes to cook and use kitchen utensils for food preparation. The Mercury enters the food system, thereby exposing the children and other family members to Mercury toxicity (Okoh and Daniels, 2016).

Furthermore, Mercury dumped straight into streams close to mining sites changes into Methylmercury, which can directly affect fish and other marine species. There are many instances where Mercury diffuses into the water systems because of mining operations. For example, well-1 (6.4534.95- mg/l) and well-2 (3.0212.29- mg/l) have Mercury contamination due to copper mining (Palanivel, 2019). Mercury concentrations are exhibited above the WHO standards.

4.2.2 Dentists working with amalgam

Many medical tools contain Mercury, such as mercury-filled tubes. Moreover, the Mercury-containing devices are not properly disposing of the solid waste streams, causing environmental contamination (Subeshan et al., 2023; Okoh, 2015). The dental professionals prepare the amalgam, which is frequently utilized in dental amalgam, and causes Mercury pollution. Dentists tend to be assisted by male and female dental assistants who are more likely to deal with dental amalgams, which may directly impact human health. It has been investigated that children and newborn infants are more susceptible to Mercury exposures, frequently exposed to various electromagnetic field sources, and the health impacts of amalgam fillings (Mortazavi, 2015; Tibau, 2019). However, the complete analysis was investigated by the Environmental Protection Agency (EPA) on dental amalgam emissions, and the current report shows 635 tons of Mercury released into the environment from dental amalgam, which is far more than the EPA's estimate of 0.6 tons/year (Scarmoutzos, 2019).

4.2.3 People working in waste incinerators

Most of the Mercury from incinerators is thermally released by combustion and discharged into the atmosphere, where it can subsequently be re-deposited by rain (Chalkidis et al., 2020). Mercury added waste products into the garbage, which directly affects human health. Therefore, mercury-added products are screened by the waste management from the waste materials before being burned. The incineration process is also harmful to humans and the environment. People working in such areas are affected by the incineration process. An advanced incineration technique should be used rather than a traditional one. The conventional methods have several limitations (Charvát et al., 2020).

4.2.4 People eating fish contaminated by Mercury

The Mercury in fish affects both genders, children, expectant women, and women of an older age are more likely to be exposed to Mercury. This is because their growing organ systems, such as brain development in a fetus, are vulnerable to the harmful effects of Mercury. The research indicates that adults at higher risk for cardiovascular illness are methylmercury sensitive due to their large amounts. Cardiovascular diseases are also common as the general recommendation level for fish Mercury concentrations set by the European Commission (EC) and the World Health Organization (WHO) is 0.5 ppm, with a maximum 1.0 ppm «exemption» for larger fish species (such as swordfish, sharks, and some tuna species). This threshold is comparable to the United State Environmental Protection Agency (US-EPA) «no consumption» standard and based on this reference dose of 1×10^{-4} mg of Mercury/kg of body weight/day, an adult female's body weight of 132 pounds (60 kg), and a fish meal size of around 6 ounces (170 grams), seafood Mercury concentrations and related meal frequency limits were determined. The recommendations apply to fish muscle tissues since over 95% of Mercury is in methyl form. However, a survey study has also reported that 90% of respondents having symptoms consistent with methylmercury poisoning, such as headaches, sleeplessness, lassitude, impaired hearing, vision, and sensory problems, by eating seafood is the cause of the methylmercury (MeHg) symptoms (Palathoti, 2022). In Oman, the study reported health risks as the Oman sea fish species estimated weekly intake and Mercury was found to be $0.49 \mu\text{g kg}^{-1}$, which is less than 1 in the following WHO standards, the fish consumers of fish species are not highly exposed (Okati, 2021).

4.2.5 Women using beauty products containing Mercury

Women are highly vulnerable when utilizing personal care items like soaps, lotions, and shampoos that contain Mercury. Mercury added preservatives in cosmetics, and skin-lightening lotions were examined, which shows the significant source of mercury exposure. However, local women use skin-lightening creams to cover up sun-induced imperfections, and the public may be unaware of the usage of dangerous chemicals in cosmetics. Mercury is a preservative in cosmetics, as these skincare products contain Mercury. This is highly caused by the incidence of miscarriages in Women in developing nations due to the higher concentrations of heavy metals in these products, as it has been analyzed that the whitening skin carries Mercury content of 5,700-126,000 ppm (Bray, 2016).

4.2.6 Selected cases of vulnerable group and communities in Oman

In the Oman Toxicology Laboratory, the Ministry of Health has analysed several Mercury samples. It was observed that the local population mostly stays in the interior part of the country and prefers treatment with herbal remedies. However, it has been found that this contains heavy metal contaminants. It has been investigated that many herbal remedies are hazardous at specific doses. Therefore, the traditional medications are toxic for the treatment. The harmful effects of these herbal remedies may result in carcinogenicity, kidney problems, neurological and cardiovascular disorders, blood problems, and many skin problems. Therefore, mercury contamination from traditional remedies is highly significant for human health. The study resulted in higher amounts of mercury content (0.74 ppm-44.292 ppm), indicating the human health risk; the face-whitening creams and cosmetics products pose an urgent risk to public health. However, about 80% of cosmetics have been marketed by 2024, which may present Mercury exposure due to the usage of these cosmetics containing Mercury (Cosmetics-Oman, 2024). Some case studies were presented on the severe effects of mercury on human health.

Case #1

A 24-year-old man with recurrent seizures the photograph is given below,

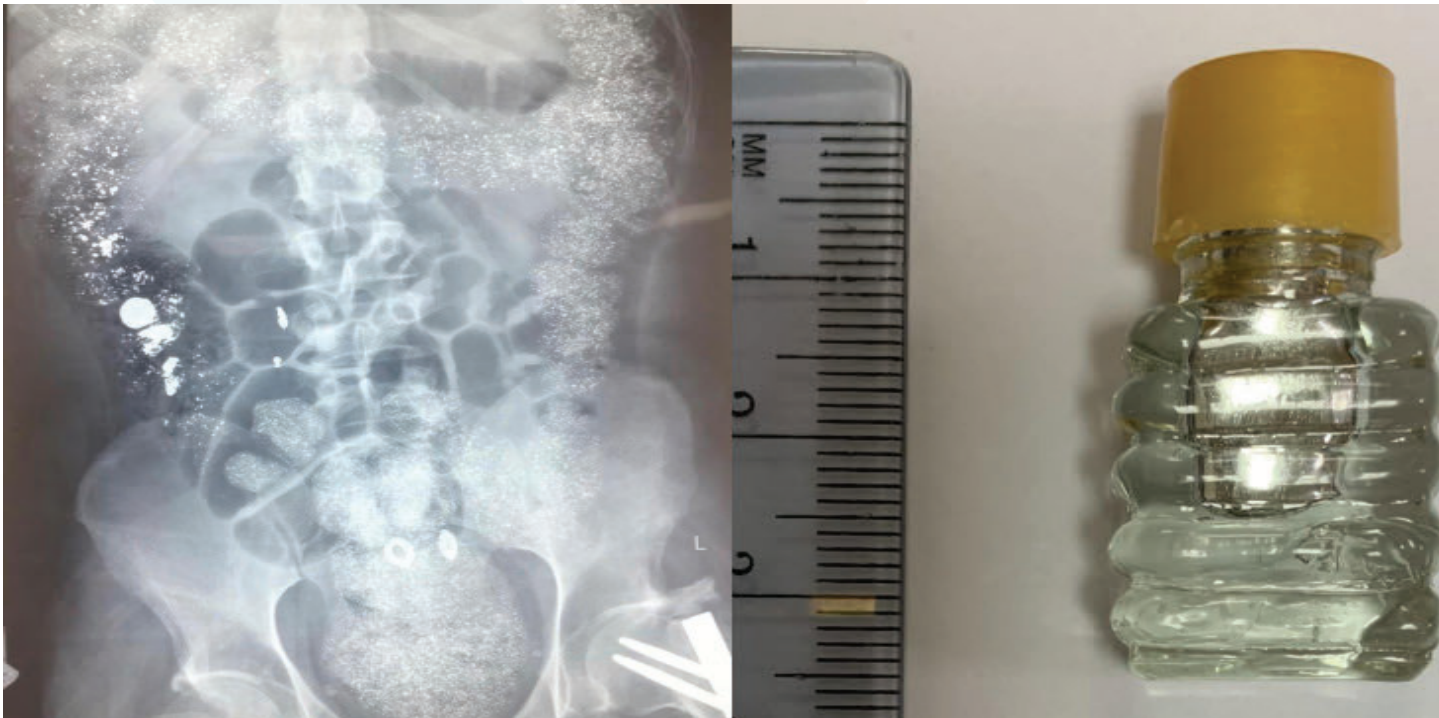


Photo 1. A 24-year-old man with recurrent seizures

Case #2

A 29-day-old male child was brought to the emergency department with a sudden onset of excessive crying, poor feeding, and lethargy. The baby deteriorated rapidly, requiring intubation, mechanical ventilation, and intensive care. The baby remained hypotensive with hypothermia. The baby was given vasopressors, antibiotics, and an antiviral. After examination, it was found that his initial serum and urine Mercury concentrations were 122 ug/L (acceptable range <15 ug/L) and 123 ug/L (acceptable range <10 ug/L). The baby was further given penicillamine 30 mg/day. The child improved clinically and was extubated at D10. The repeated blood and urine Mercury was 15 ug/L and 39 ug/L at 14 days post-admission; however, he did not show any residual neurological deficit at the age of 2 and 3 months.

Case #3

The forensic department diagnosed the 12-year-old girl who was brought dead to the emergency department, the family history inquired with altered mental status and poor appetite, which started one week earlier. The girl's serum was identified with Mercury concentrations of 236.9 ug/L. However, particular to the patient, herbal medication collected from a relative causes the treatment of the disease.



Photo 2. A 29-day-old male child was brought to the emergency department with a sudden onset of excessive crying

4.4

Summary

Men should be the primary focus of occupational exposure, particularly in the first responder and waste management fields. However, in the medical field, mercury poisoning risks are the same for men and women. Women are a more significant target group for dietary updates on methylmercury and mercury in cosmetics. These tendencies help develop gender-sensitive communication techniques to target the sexes differently to maximize benefit when considering training, education, and awareness-raising strategies about mercury exposure. The hazards of using mercury in different traditional remedies and its associated toxicity are significant public concerns. Unawareness of mercury sources, their health impact, and how to avoid them carries a constant danger. The health effects of mercury are more devastating in the paediatric population, concerning the developing CNS (central nervous system).

Chapter 5: Training and Awareness Campaign to Contain the Toxic Impact of Mercury



5.1

Introduction

Workers and the public can be protected from the negative effects of Mercury by being aware of its toxicity. Mercury exposure comes from a variety of sources every day. Someone working in the coal combustion industry or a dentist treating patients in his clinic could inhale Mercury when doing amalgam fillings. Similarly, Mercury exposure is a significant danger for those working in other occupations, such as waste collection, incineration, and treatment. Another prevalent method of exposing humans to Mercury toxicity is ingesting methyl Mercury through fish. In addition, using cosmetics can be a double-edged sword since while they might provide consumers with a sense of mental fulfillment, they can also hurt their health. The most crucial weapon in the fight to shield the public from Mercury poisoning is awareness. If workers and residents in residential and commercial settings are properly informed about the harmful effects of Mercury and how to avoid it, they can take various precautions.

Oman has started educating people about the negative effects of Mercury and its environmental contamination. These awareness programs concentrated on important industries and sectors, such as health, labor and productivity, industry, mining and steel, agriculture, and non-governmental organizations. This chapter described the awareness campaigns, and the Environment Authority ensured the awareness campaigns about the contamination through Mercury and its potential risks were effectively communicated to the public and society organizations, as well as the media, it will be crucial to make use of the mechanisms currently in place through the ministries to deliver well-coordinated information campaigns to vulnerable populations and important stakeholders.

5.2 Initiative by the Environmental Authority Oman to contain the impact of Mercury

The Sultanate of Oman's successful implementation of the Minamata Convention on Mercury depends on raising public knowledge of the possible dangers of Mercury exposure and usage. Currently, the Environmental Authority ensures that Mercury risk is effectively communicated to the public and decision makers in all sectors of the Omani society. Since the Minamata Convention was developed, and there has been a growing global concern about mercury contamination, Oman has started implementing awareness programs regularly on the harmful effects of mercury. These training and awareness campaigns have focused on key industries such as health, mining and steel, industry, agriculture, labour and productivity, non-governmental organizations, and academics.

The Minamata Convention aims to protect the environment and public health against anthropogenic emissions and Mercury releases, as part of the Minamata Initial Assessment initiative. The meeting on 7-8 March 2022, outlined the goals and objectives of the MIA Project in Oman, and the EA has been invited, with the involvement of several ministries, stakeholders, and served as the first venue for discussing national Mercury management methods. Representatives from the United Nations Institute for Training, Research and Education, with the coordination of higher authorities UNEP and academia, attended with media people as one of the awareness campaigns through local newspapers and TV channels and with other representatives.



Photo 3. EA presenting on national TV Oman as MIA Convention representative



Photo 4. EA and UNEP training workshops for Mercury contamination

5.3 Awareness campaign on the health risks of Mercury

The Environmental Authority of Oman has organized several ministerial and public events that brought together stakeholders from health, mining and steel, industry, labor and productivity, NGOs, academia, and policy makers to discuss the gradual reduction and use of mercury-containing products. Additionally, workshops were organized to validate the inventories and Mercury profiling initiatives for national stakeholders.



Photo 5. EA awareness campaigns for MOD on the health risks of Mercury



Photo 6. EA awareness campaigns for MOH and ministerial officials on Mercury



Photo 7. EA awareness campaigns for public on Mercury



Photo 8. EA and UNEP training workshops on solution analysis of Mercury



Photo 9. UNEP Official Keynote Speech on Mercury Contamination in Oman



Photo 10. Mercury analysis and remedial protocols Oman Poison Control Center

5.4 Training program

The training program was managed and supervised by the Environment Authority: Mohammed Al-Kasbi, Azhar Juma Al-Hinai, Hassan Al-Kaanuini, Sajjad Ahmad Siddiqi, Abdullah Al-Mufarji, and Abdullah Saleh. United Nations Environment Programme (UNEP): Iyngararasan Mylvakanam and Yara El Khoury. The international expert UNEP was Prof. Motasem Saidan.

5.4.1 Training 1: Practical, and technical trainings, and advisory services United Nations Environment Programme (Monday February 13th, 2023)

The United Nations Environment Programme (UNEP) Regional Office for West Asia (ROWA) in Oman organised several meetings between the consultant and the Oman national teams developing the Minamata Initial Assessment (MIA) for the Minamata Convention on Mercury. The training on the MIA in Oman enabled the Omani team to draft the outline of the Mercury inventory analysis report, based on the UNEP-approved report template, and discuss the next steps in implementing the project. A detailed participant list is provided in Annex 1.

In the training, the discussion started with an overall explanation of the Mercury inventory analysis report's chapters to the Omani drafting team, which will be incorporated in the final MIA. The training highlights and explains how to integrate the different sources into the various sections, which the team had already retrieved from the UNEP Toolkit, and the Oman team prepared that. The template was displayed, which was used by various other countries as well, throughout the discussion to explain in further detail the different sections and parts, as well as highlight the items that they need to elaborate on in detail (highlighted in yellow) and the parts that do not require any modifications.

5.4.2 Training 2: Practical, and technical trainings, and advisory services United Nations Environment Programme (February 17th, 2023)

The United Nations Environment Programme (UNEP) Regional Office for West Asia (ROWA) in Oman organised several meetings between the consultant and the Oman national teams developing the Minamata Initial Assessment (MIA) for the Minamata Convention on Mercury. As part of the efforts of the Sultanate of Oman to facilitate the early implementation of the Minamata Convention, the Sultanate is in the process of developing the Minamata Initial Assessment (MIA) with the support of the Global Environment Facility (GEF) and the United Nations Environment Programme (UNEP). Hence, an online meeting was held on the 17th of February 2023, under the Minamata Initial Assessment (MIA) for the Minamata Convention on Mercury for the Sultanate of Oman project to draft the MIA report based on the UNDP MIA Guidelines and discuss the next steps in the implementation of the project. The training on the MIA in Oman was to provide a detailed explanation of the draft of the MIA report based on UNDP MIA Guidelines. The training was held remotely and online. The workshop gathered representatives from various ministries in the Sultanate of Oman who were concerned with chemical management. This training discussed the overall explanation of the MIA report's chapters to the Omani drafting team. A report template was displayed throughout the discussion, a structure approved by UNEP and used by many other countries, to explain the various chapters and parts in further detail and highlight the items they need to elaborate on. The general structure of the document was described, and multiple stakeholders were asked to coordinate to compile as much data as possible.

5.4.3 Training 3: Practical, and technical trainings, and advisory services United Nations Environment Programme

The United Nations Environment Programme (UNEP) Regional Office for West Asia (ROWA) in Oman organised several meetings between the consultant and the Oman national teams developing the Minamata Initial Assessment (MIA) for the Minamata Convention on Mercury. The meeting and discussion aimed to oversee the Mercury inventory analysis report development. The meeting was held remotely and online. Conducting meetings with team members and UNEP, and providing comments and advisory services on the drafted Mercury inventory analysis report, several meetings and discussions were held to review the inventory's narrative report. Comments of the international expert guided not to include the weight of the items, but the number and type of the items are needed in the excel sheet. The number must be estimated by customs and the companies importing the items. Ask the company «Be'ah» about the future of the 16 tons of batteries, whether they are recycled, reused, or disposed of, regularly communicate with the Team, and provide comments and advisory services on the drafted report.

5.4.4 Training 4: Microsoft Teams Meeting (November 28th - 29th, 2022)

The purpose and objective of the training includes two main parts to include, the Review and Assessment of information and data gathered for the development of the Mercury inventory in Oman, the legal and institutional frameworks to manage Mercury in Oman, the workshop debuted with an introductory session by UNEP, that highlighted the significance of the milestones that have been reached by the project team including the gathering of information and data related to the Mercury inventory and the insertion of these data in the Toolkit-Level 2. The UNEP representatives also addressed the importance of drafting the legal and institutional gaps, options, and recommendations for enhancing the Mercury inventory development in Oman. The international consultant (Prof. Motasem Saidan) reviewed the gathered data and information for Mercury inventory, the insertion of these data in the Toolkit-Level 2, and the legal and institutional gaps, options, and recommendations. Prof. Saidan addressed his comments and review inputs on these two tasks to project team discussed with the team every single input data and shared with the team his suggestions of data corrections and inclusions, as well as, he has pointed out the necessity of revisiting some sources of releases and suggested other options to be focused on.

5.4.5 Training 5: Microsoft Teams Meeting Attendance (August 5th - 7th, 2022, Time: 9:00, Bahrain Time)

This training workshop, conducted for the national stakeholders related to implementing the Minamata Convention in the Sultanate of Oman, was held between 5th and 7th August 2022. Various stakeholders in Oman attended the training. A detailed participant list is provided in Annex 2. The primary purpose and objective of the training includes two main parts: the development of the Mercury inventory in Oman and providing a good understanding of the steps in planning, preparing, implementing, and analysing the Mercury inventory. In this training the national team was further comprehend in the compilation and development of the Mercury inventory using the UNEP Mercury inventory level 2 toolkit and the legal and institutional frameworks to manage Mercury in Oman, which includes to train the national team on the compilation and assessment of the existing policy, institutional and legal frameworks for the management of chemicals, specifically Mercury in the country data.


The training also includes the understanding and providing insights on the challenges and recommendations in managing Mercury in the country. This training debuted with an introductory session by UNEP, which gave an overview of the project that focuses on implementing the Minamata Convention and developing the Mercury inventory in Oman, including the Mercury component. The training then followed by an overview of the Minamata Convention and further explanation

of the Mercury included in the obligation to comply to the convention. The stakeholders who participated in the training included national agencies such as the Ministry of Health, the Ministry of Commerce and Industry, the Ministry of Energy and Minerals, Oman Environmental Service Holding Company S.A.O.C (be'ah), the Ministry of Labour, the Ministry of Energy and Minerals, the Ministry of Interior, and many other agencies. Further explanations were then provided by Dr. Motasem, international consultant, on the purpose of the planning, preparing, implementing, and analysing the Mercury inventory. Moreover, the MIA national team was trained on compiling and developing the Mercury inventory using the UNEP Mercury inventory level 2 toolkit.

Moreover, throughout the training, the toolkit was displayed to the participants. Prof. Motasem explained how to use the toolkit and the data needed for the spreadsheet. On the last day of the training workshop, Dr. Motasem provided an overall summary on the data collection and assessment of the policy, legal, and institutional frameworks for the management of Mercury in the Sultanate of Oman. At the end of training, a complete summary was also provided on the outline report developed, in addition to providing a further explanation of the identification of the gaps and recommendations in the management of Mercury in the country. The focus was highlighted on identifying the existing legal instruments for managing chemicals, particularly Mercury and Mercury compounds within the country. Furthermore, identifying the relevant national institutions and their capacities for managing chemicals and implementing the Minamata Convention was addressed. In addition, the linkages between existing capacities and the relevant articles of the Minamata Convention were highlighted.

5.5 Summary

This chapter presents the awareness campaigns on Mercury toxicity. The Environment Authority of Oman ensured the successful awareness campaigns on Mercury contamination and its potential risks. Using the mechanisms currently in place through the ministries to deliver well-coordinated information campaigns to vulnerable populations and essential stakeholders will be crucial.



Chapter 6: Implementation Plan and Priorities for Action

6.1

Introduction

Designing and implementing the Mercury contamination control mechanisms in Oman is essential. The current study has opened a new avenue for implementation and priority areas. A set of priority actions resulting from the MIA convention on Mercury contamination, which outlined previous data inventory and other chapters, is discussed. In addition to highlighting the importance of case studies and research, policy guidelines have been set as one of the priority areas. Protecting vulnerable populations involved in mining activities from practices that harm the environment and public health is one of the ways that Mercury contamination control is being carried out. In addition to this, the other strategies include establishing the administrative and regulatory frameworks that are necessary for the Convention to operate effectively at the national level, working with investors and the private sector to control emissions and releases from industrial sources, outlawing or restricting the use of products containing Mercury and urging consumers to accept alternatives.

Furthermore, working on increasing the capacity to store Mercury waste, converting former dumps and landfills into engineered landfills, and enhancing the ability to manage the Mercury waste and contaminated areas (including the air, soil, and water) are some primary goals. The field will benefit from improved institutional and legal frameworks that will make designing relevant laws and regulations easier. Further, to help persons affected by Mercury and Mercury compounds, awareness-raising initiatives, workshops, and preventive measures are required. Finally, the inspection plan will outline the procedures for inspecting industries, operations, and activities to comply with the Mercury-related laws and regulations. However, there will be inspections at different risk levels of Mercury contamination.

6.2

Recommendation on policies, and regulations

Article 20 of the Minamata Convention describes the following guidelines: Each Party may, following an initial assessment, develop and execute an implementation plan, con-sidering its domestic circumstances, for meeting the obligations under this Convention. Such a plan should be transmitted to the Secretariat as soon as it has been developed. In addition, each Party may review and update its implementation plan, considering its domestic circumstances and referring to guidance from the conference of these parties and other relevant guidance. Furthermore, in undertaking work in paragraphs 1 and 2 of Article 20 of the Minamata Convention, these parties should consult national stakehold-ers to facilitate developing, implementing, reviewing, and updating their implementation plans. Considering the guidelines and objectives of the Minamata Convention, this section presents the priority areas, outlines, and implementation plan for Oman.

6.3 Implementation plan, budgets and required resources

6.3.1 Priority 1: Enhancing the institutional and legal framework

After identifying this difficulty in improving the institutional and legal framework, the action plan and implementation strategy would be based on the promises made upon ratifying the Convention. State authorities, pertinent NGOs, and other stakeholder's communities are to carry out the measures in the action plan. The field's institutional and legal framework will be enhanced, facilitating the creation of appropriate laws and regulations. Table 6.1 shows the implementation plan, budget, and required resources.

6.3.2 Priority 2: Environmental management - Mercury added products and wastes

One key objective is to increase the storage capacity for Mercury waste, convert old landfills and dump sites into engineered landfills, and increase capacity for managing Mercury waste and polluted areas (such as the air, soil, and water). Necessary actions will include reducing the use of tools, equipment, and gadgets that contain Mercury, especially those that come from point sources, and minimizing environmental and public health effects. Table 6.1 shows the implementation plan, budget, and required resources.

6.3.3 Priority 3: Education and awareness campaigns and workshops

Campaigns, workshops, and preventive actions are needed to assist those impacted by Mercury and Mercury compounds. The interchange of scientific, technical, economic, environmental, and legal information on chemicals, including information on environmental safety, ecotoxicological and toxicological concerns, Mercury, and Mercury compounds, will further increase awareness. Table 6.1 shows the implementation plan, budget, and required resources.

6.3.4 Priority 4: Research and development on Mercury contamination

It is vital to include scientific research and development to outline the significant tasks that must be completed after ratifying the Minamata Convention. Preparing pertinent reports by the National Authority for the nation on the fulfilment of the obligations undertaken by Oman in the manner and within the timeframe established by the Convention to investigate within the Action Plan. Table 6.1 shows the implementation plan, budget, and required resources.

6.3.5 Priority 5: Technical training and capacity building

The technical training, capacity building for monitoring, evaluation, and inspection plan will be strengthened by the training on inventory data and the technical training on equipment from the existing and operational laboratories that can analyse Mercury levels. The assessment and inspection plan aims to establish the laboratories by the International Organization for Standardization (ISO) to standardize Mercury contamination. The capacity building would help monitor,

evaluate, and inspect Mercury levels at a large scale, especially designed for Mercury pollution, which requires careful efforts to identify and reduce the risks related to Mercury. However, the development of shipments monitoring and inspection of Mercury related products at Oman customs including establishment of weighing instruments and tools, in specifying the (Harmonized System) HS codes of Mercury containing materials, large scale monitoring points in establishing of laboratories system and providing tools for the pollution prevention and treatment of the contained sites. The primary goals of the monitoring plan will be tracking high concentration levels, identifying parameters that indicate the levels of methylmercury and total Mercury using a sampling strategy, and outlining the locations, frequencies, and sampling techniques for the risk assessment. The primary objectives will also be to evaluate, identify, quantify, and manage Mercury pollution with statistical analysis, regulatory standard comparison, and health risk assessment. Finally, prioritizing the technical training and capacity building for the inspection plan will provide protocols for examining establishments, operations, and activities to ensure that they comply with rules and regulations about Mercury. Inspections will take place at various risk levels. Table 6.1 shows the implementation plan, budget, and required resources.

No.	Activities	Timeline and budget (USD)			Grand Total (USD)	
		Year 1	Year 2	Year 3	Total	
Priority 1: Enhancing the institutional and legal framework						
1.1	Regulations amendments.					
1.2	Policies, guidelines for mining and processing coal, ores, and industrial minerals.					
1.3	Design regulations to prohibit or restrict mercury-added products' production, trade, use, and disposal.					
1.4	Institutional framework revisions are needed to remove inconsistencies and avoid overlapping mandates.	175,000	175,000	175,000	525,000	525,000
1.5	Implement the responsibilities among regulatory authorities for effective implementation plans.					
1.6	Basel Convention implementation on the control of hazardous wastes and their disposal.					
1.7	Develop compatible regulations and administrative rules to implement the Minamata Convention in Oman.					
	Sub-total	175,000	175,000	175,000	525,000	

Priority 2: Environmental management - Mercury added products and wastes						
2.1	Program for phasing out Mercury-added products.					
2.2	Feasibility studies on waste management and proof of concepts for environmental management.					
2.3	Separation of Mercury-containing products from municipal waste streams.	250,000	250,000	250,000	750,000	750,000
2.4	Separation of discarded medical devices containing Mercury from clinical wastes.					
2.5	Development of storage capacities for Mercury waste before disposal under the terms of the Basel Convention.					
Sub-total		250,000	250,000	250,000	750,000	
Priority 3: Education and awareness campaigns, workshops, technical trainings, and capacity building						
3.1	Establishment of an integrated awareness plan with all stakeholders.					
3.2	Communication with representative authorities, professional associations, meetings, stakeholders, and other private organizations.					
3.3	Establishment of communication with vulnerable groups and local communities for control and prevention.					
3.4	Training and education on awareness for the public and local communities.	245,000	245,000	245,000	735,000	735,000
3.5	Capacity building for implementing the MIA convention.					
3.6	Improvement of personnel at the Poison Center of Oman who respond to emergencies and gather, examine, analyze, and distribute data.					
3.7	Research training and workshops introducing Mercury control protocols for local communities, training on IT systems, and GPS skills.					
Sub-total		245,000	245,000	245,000	735,000	

Priority 4: Research and development on Mercury contamination						
4.1	Technical Communication with representative authorities, academic professional associations, and meetings, pollution reduction consultants.					
4.2	Educational program to conduct Mercury contamination research.					
4.3	Development of procedures and providing tools and instruments for the poisoning control center.	225,000	225,000	225,000	675,000	675,000
4.4	Study on Mercury-containing products, including thermometers, light sources, electrical switches, etc. For instance, Mercuric oxide dry batteries for portable devices (HS Code - 85063010), Mercury or sodium vapor lamps; Metal halide lamps (HS Code - 85393200), Thermometers that are not shared with other instruments that contain a liquid for reading (HS Code - 90251100) and other thermometers not shared with different tools (HS Code - 90251900).					
Sub-total		225,000	225,000	225,000	675,000	
Priority 5: Technical training and capacity building						
5.1	Development of shipments monitoring and inspection of Mercury-related products at Oman customs.					
5.2	Establishment of weighing instruments and tools.					
5.3	Specifying the HS codes of Mercury and Mercury-containing materials.	650,000	650,000	650,000	1,950,000	1,950,000
5.4	Establishment of laboratories for monitoring and evaluation.					
5.5	Establish a system and provide tools for preventing and treating pollution at contaminated sites.					
Sub-total		650,000	650,000	650,000	1,950,000	

Table 6.1 Implementation plan, budget, and required resources

6.4

Summary

This chapter presents the impact of Mercury contamination on human health and the environment, along with the solutions to contain it. Five priority areas are listed in this chapter. The cost of implementation and timelines are also described. For examples, Priority 1: Enhancing the institutional and legal framework, Priority 2: Environmental management (Mercury added products and wastes), Priority 3: Education and awareness campaigns, workshops, technical trainings and capacity building, Priority 4: Research and development on Mercury contamination, Priority 5: Technical training and capacity building.

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