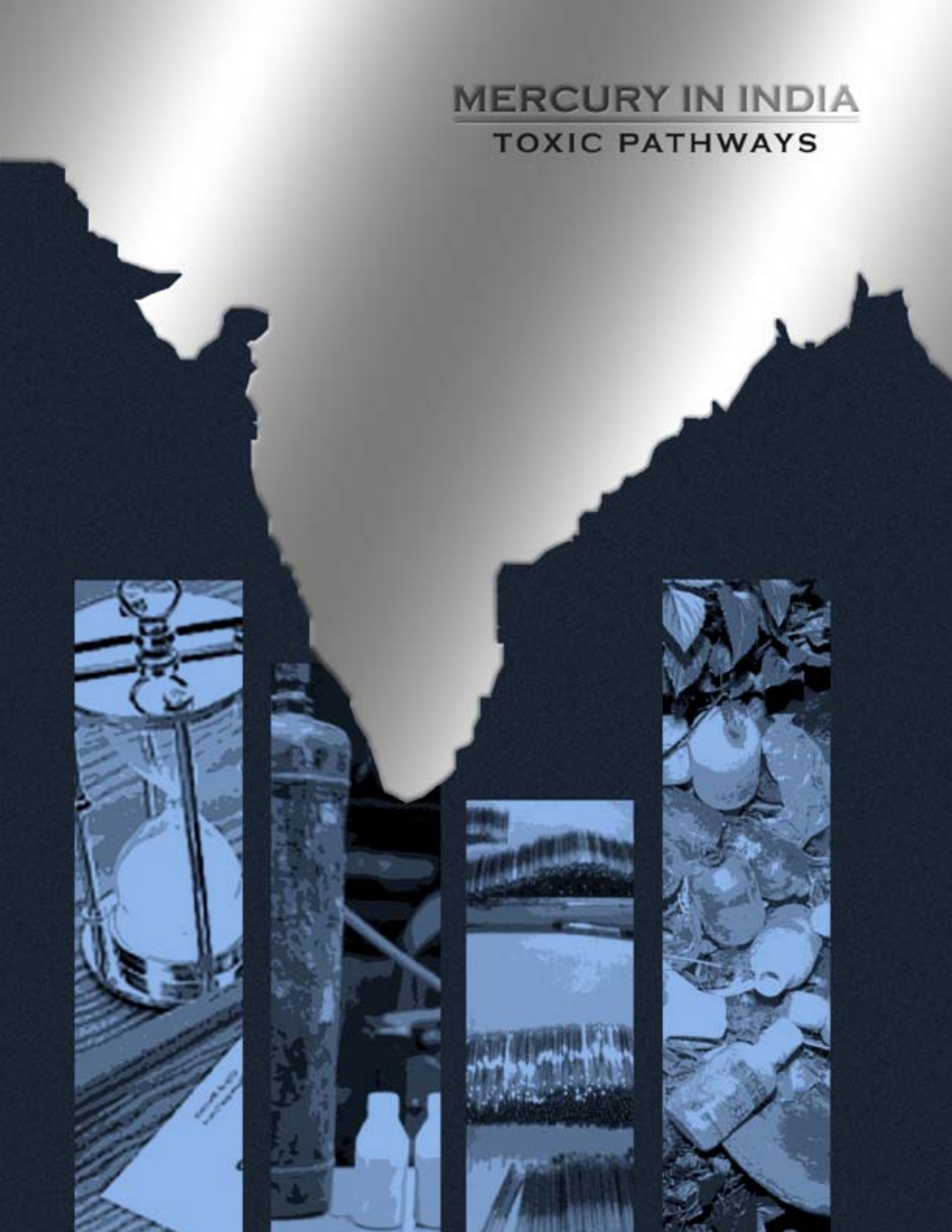
MERCURY IN INDIA

TOXIC PATHWAYS



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Toxics Link

September 2003

Who we are

Toxics Link is an environmental organisation with the goal of disseminating information about toxics to help strengthen campaigns against toxics pollution, provide cleaner alternatives and bring together groups and people concerned with, and affected by, this problem.

"We are a group of people working together for environmental justice and freedom from toxics. We have taken it upon ourselves to collect and share both information about the sources and dangers of poisons in our environment and bodies, and information about clean and sustainable alternatives for India and rest of the world."

This current report was undertaken in light of the UN-based global mercury assessment. The worldwide NGO community participated in this process through the BAN-HG Working Group. The group was initiated by the Basel Action Network (www.ban.org) and the Mercury Policy Group in association with other groups worldwide. Toxics Link acted as the Southern NGO Representative in this process.

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EXECUTIVE SUMMARY

The addition of even 0.9 grams of mercury, that is, one minuscule fraction ($1/70^{th}$) of a teaspoon – is enough to contaminate a 25-acre lake, and render fish contaminated and unsafe to eat. This is the nature of mercury, a potent neurotoxin. 'Mercury' brings forth horrific images of the Minamata catastrophe – the devastation which mercury poisoning brought about, claiming thousands of lives in Japan in the decade of the '50s and '60s. Minamata is a small bay in Japan where a chlor-alkali plant had been dumping its mercury-laden waste for years. Mercury, when mixed with water, is methylated and becomes the more dangerous methyl mercury; it accumulates in the tissues of fish, thus contaminating them. The villages on the bay used to eat fish as a staple diet from the contaminated waters of the bay, and were thus poisoned by the mercury. This was the first incident of mercury poisoning at a large scale, and has since been known as the 'Minamata disease' globally.

Mercury (Hg) is a naturally occurring, highly volatile heavy metal. It is found in trace quantities throughout the environment – rocks, soil and the oceans. Being an element, mercury never breaks down but persists in the environment, cycling through land, air and water and travelling beyond international borders.

The dispersion of mercury into the environment is a major concern in the world today, especially in developing countries. In India various reports have indicated the levels of mercury in river and coastal water; soil and food items are way above acceptable levels.

Even at extremely low levels of exposure, mercury can cause permanent damage to the human central nervous system. At higher levels, it damages vital organs including lungs and kidneys. The most common exposure routes involve food and diet. Additional exposures may be contributed through air and water, either directly or again through the route of food.

Today mercury levels are extremely high in the working environments of industrial processes such as chlor-alkali plants, mercury mines, thermometer factories and even medical practices such as dental clinics. Air exposures can be caused through thermal power plant emissions. A typical 100 megawatt thermal power plant can emit over 10 kg of mercury in a single year. About 200 metric tonnes of toxic mercury escapes from industrial chimneys and effluents each year in India.

In fact, mercury usages in most cases are substitutable by other methods. For example, the membrane cell process is a sustainable alternative to mercury cell process in the chlor-alkali industry. Similarly all mercury based measurement instruments, such as thermometers, barometers and blood pressure monitors, have an alternative in digital instruments, which are accurate and have longevity.

In terms of import and internal consumption, mercury has always been important to various industries owing to its 3,000 industrial uses. The chlor-alkali, thermometer and other instruments, and fungicide industries are the biggest source of consumption in India. Coal-fired thermal power plants are the biggest source of emission along with the chlor-alkali industry in India.

There is no 'safe disposal' for mercury. Once in the waste stream, it is bound to enter our environment. Thus the only way out is a comprehensive policy both at the national and international levels. Unless there is a change in government policies, mercury would be haphazardly released into the environment.

The UNEP Governing Council felt that there is sufficient evidence of significant global adverse impacts to warrant international action to reduce the risks to human health and the environmental arising from the release of mercury into the environment. This led to the establishment of a Global Mercury Assessment Working Group to assist the UNEP to prepare a *Global Mercury Assessment Report*.

The *Report* was released recently; it has named Asia as the biggest villain in polluting the atmosphere with new mercury emissions, which is impacting the health of people and wildlife. The first global study on mercury says: "India could be one of the dozen hot-spots after the rise in mercury emissions over 30 years." Launching the *Global Mercury Assessment Report* in Nairobi, UNEP executive director Klaus Toepfer said action is essential.

INTRODUCTION

The dispersion of toxic metals in the environment is a major concern in many industrialised countries. Although mercury occurs naturally in the environment, human activity causes most mercury releases and has altered the natural cycling of the element. Mercury's presence in our air and water has increased dramatically in the past century due to human activity. Recent studies suggest that the total global atmospheric mercury burden has increased between 200 and 500 per cent since the beginning of the industrial age.

Reports also indicate that levels of mercury in rivers, coastal waters, soil and food items are way above acceptable levels in India. In fact, in most cases, mercury usage is substitutable and not doing so reflects a lack of concern about this extremely toxic heavy metal.

Mercury is a silvery white, poisonous, odourless, metallic element, which is an extremely heavy liquid at room temperature. Its chemical symbol, Hg, is derived from the Greek word ''hydrargyrum', meaning 'liquid silver', or 'quick silver'. Although now obsolete, the word 'quicksilver' was for a long time a synonym for mercury.

The element constitutes only 0.5 parts per million (ppm) of the earth's crust, making it scarcer than uranium but more common than gold or silver. Mercury is principally found as the ore ***cinnabar*** (mercury sulphide) but is also found in an uncombined state. The preparation of mercury from its ores is simple: the ore is ground up and heated to about 580 ^{o}C in the presence of oxygen. Mercury vapour escapes from the ores and sulphur dioxide is removed. The metal is condensed and purified by washing with nitric acid, followed by distillation.

History and Occurrence

Mercury was among the first metals known, and its compounds have been used throughout history. Archaeologists have found mercury in an Egyptian tomb dating from 1500 BC. The Egyptians and the Chinese may have been using cinnabar as a red pigment for centuries before Christ's birth. In many civilisations, mercury was used to placate or chase away evil spirits. Alchemists thought that mercury, which they associated with the planet Mercury, had mystical properties and even used it in their attempts to transmute base metals into gold. The Greeks knew of mercury and used it as a medicine. Mercury and mercury compounds were used from the 15th century to the mid-20th century to cure syphilis. However, since mercury is extremely toxic and its curative effect unproven, other syphilis medi-

cines are now used. These days, its poisonous nature and scarcity limit mercury's uses.

Physical and Chemical Properties

The element shares group II B of the periodic table with zinc and cadmium. Mercury's atomic number is 80; its atomic weight is 200.59. Mercury is very heavy: it has a density of 13.534 at 25 °C, which means that it weighs 13.6 times an equal volume of water. Stone, iron, and even lead can float on its surface. Mercury only occurs in trace amounts in igneous rocks; sedimentary rocks are slightly richer.

It is a rather poor conductor of heat if compared to other metals, but a good conductor of electricity. It alloys easily with metals such as gold, silver and tin, which are called amalgams. Mercury is a fairly unreactive metal and is highly resistant to corrosion. Its boiling point is 356.72 °C and its melting point -38.87 °C, which means that it will be vaporised in furnaces or waste incineration process. Mercury oxidises in air to form mercuric oxide. At 500 °C, mercuric oxide decomposes into mercury and oxygen. The most commonly used compounds are mercuric chloride or $HgCl_2$, mercurous chloride or Hg_2Cl_2, mercury fulminate or $Hg(ONC)_2$ and mercuric sulphide or HgS.

Sources in the Environment

Mercury is probably best known as the silver liquid in thermometers. However, it has 3,000 different industrial uses. Mercury and its compounds are widely distributed in the environment as a result of both natural and man-made activities. The utility, and the toxicity, of mercury have been known for centuries. New toxicological evidence demonstrates that even low levels of mercury exposure may be hazardous. Natural mercury arises from the degassing of the earth's crust through volcanic gases and, probably, by evaporation from the oceans. Local levels in water derived from mercury ores may also be high (up to 80 µg/litre). Atmospheric pollution from industrial production is probably low, but pollution of water by mine tailings is significant.The burning of fossil fuels is another source of mercury. The chlor-alkali industry and, previously, the wood pulping industry, also released significant amounts of mercury.

Although overall use of mercury has been reducing, substantial concentrations of the metal are still present in sediments associated with the industrial applications of mercury. Some mercury compounds have been used in agriculture, principally as fungicides.

Exposure and Distribution

The extent of exposure to mercury depends on its form, with mercury vapour and methyl mercury being the most likely forms since they are completely absorbed into the body. Methyl mercury in fish and fish products is by far the largest source of mercury exposure (94 per cent), followed by breathing mercury vapour from the air (6 per cent). Drinking water makes a negligible contribution. (These figures are averages for people not

The consumption of fish is a common route by which mercury enters the human body; freshwater fish tends to have slightly higher mercury levels than marine species.

exposed at the workplace.)

Above-average exposures to mercury vapour are primarily confined to occupations where it is used. Of special concern are women of child-bearing age who work as dentists or dental assistants and may be exposed to mercury vapour in preparing dental fillings containing mercury metal amalgams. These people/women may be exposed to above-average levels of mercury vapour on a daily basis. Because the developing foetus is especially vulnerable, pregnant dental workers are a greater concern. In addition, those finished fillings in people's teeth release mercury vapour in sufficient quantities to cause adverse health effects. People living with workers who are occupationally exposed (such as dental workers and thermometer manufacturers) may also experience higher than average exposures to mercury vapour because of mercury metal brought home on hands, hair, and clothes worn at the workplace.

People who have been documented as having above-average exposure to methyl mercury are mainly those who eat large amounts of fish. The Environmental Protection Agency, USA, states that those who eat more than 30 pounds of fish per year are in the high-risk group. Freshwater fish tends to have slightly higher mercury levels than marine species. Pike, trout, and bass are the freshwater varieties with the highest concentration rates; shrimp, snapper and halibut are the most frequently consumed marine species with the highest mercury levels. The Great Lakes, in the USA, are a unique example of high levels of concentration of mercury in freshwater fish, because of the presence of mercury above the permissible limits in their waters. The fish-eating communities living in the vicinity of The Great Lakes are the most vulnerable group to mercury poisoning.

Geographically speaking, mercury tends to be distributed in the vicinity of manufacturers using it as well as near mines, smelters, municipal solid waste incinerators, and fossil-fuel burning power plants, since mercury is a trace contaminant of ores and fuels.

Health Effects and Toxicity

Towards the end of 1956, it was established that the "strange Minamata disease" was actually mercury poisoning caused by eating fish and shellfish contaminated with methyl mercury. By the time the facts came into light, hundreds of people had been affected; some had died and children had been born with the disease. Thus the 'Minamata disease' brought to light the case of mercury poisoning.

Exposure to mercury can occur through inhalation, ingestion or dermal absorption. The amount of mercury absorbed by the body – and thus the degree of toxicity – is dependent upon the chemical form of mercury. For instance, ingested elemental mercury is only 0.01 per cent absorbed, but methyl mercury is nearly 100 per cent absorbed from the gastrointestinal tract. The biological half-life of mercury is 60 days. Thus, even after exposure is reduced, the body burden will remain for at least a few months.

Elemental mercury is most hazardous when inhaled. Only about 25 per cent of an inhaled dose is exhaled. Skin absorption of mercury vapour occurs, but at low levels (for example, 2.2 per cent of the total dose). Dermal contact with liquid mercury can significantly increase biological levels. In the human body, mercury that accumulates in the liver, kidney, brain and blood, may cause acute or chronic health effects. Acute exposure (that is, short term, high dose) is not as common today due to greater precautions and decreased handling. However, effects may include severe gastrointestinal damage, cardiovascular collapse or kidney failure, all of which could be fatal. Inhalation of 1-3 mg/m^3 for two to five hours may cause headaches, salivation, metallic taste in the mouth, chills, cough, fever, tremors, abdominal cramps, diarrhoea, nausea, vomiting, tightness in the chest, difficulty in breathing, fatigue, or lung irritation. The onset of such symptoms may be delayed for a number of hours.

Chronic effects include central nervous system effects, kidney damage and birth defects; genetic damage is also suspected. These are the most critical effects of chronic mercury exposure as they are consistent and pronounced. Some elemental mercury is dissolved in the blood and may be transported across the blood/brain barrier, oxidised and retained in brain tissue. Elimination from the brain is slow, resulting in nerve tissue accumulation.

Symptoms of chronic mercury exposure on the nervous system include high excitability, mental instability, tendency to weep, fine tremors of the hands and feet, and personality changes. The term 'mad as a hatter' derives from these symptoms, which were a result of mercury exposure of workers manufacturing felt hats.

Kidney effects: Kidney damage includes increased protein in the urine and may result in kidney failure at high doses of mercury exposure.

Birth defects: Neurological damage results from exposure to methyl mercury. The manifestations of mild exposure include delayed developmental milestones, altered muscle tone and tendon reflexes, and depressed intelligence.

Mercury exposure in children can cause a severe form of poisoning called acrodynia. The symptoms of acrodynia are pain in the extremities, pinkness and peeling of the hands, feet and nose, irritability, sweating, rapid heartbeat and loss of mobility.

The present study is aimed at presenting the status of mercury in India, with an overview of various problems of environmental pollution by mercury and its various compounds. The study also looks into the

trade pattern, that is, the import and export of mercury with reference to India. The various laws, legislations and standards on mercury in the Indian context are also looked at. The study finally provides an outline of the various research works done so far on mercury in India.

Report Structure

Chapter 1. Mercury Usage and Releases: The first chapter looks into the total usage of mercury and mercury compounds in various industries. Analyses of the releases from these industries have also been done. The chapter also highlights the amount of air emissions from various sources and health effects of mercury.

Chapter 2. Environmental and Health Aspects: The second chapter analyses the environmental and health aspects of mercury in the Indian scenario. It details how mercury enters our environment and bodies.

Chapter 3. Trade in Mercury: The third chapter attempts to understand the economics of mercury trade. A data analysis of import and export figures of mercury and mercury-based compounds has been carried out in order to understand the dynamics of mercury trade in India.

Chapter 4. Standards and Legislations: In the last chapter, an attempt is made to look into the laws, standards and policies pertaining to mercury in India. A brief review has also been carried out to understand them.