A study of heavy metal pollution cd in the aquatic environment of mumbai by spect...

Business

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Abhijith Shishir Mandya SUMMARY Environmental pollution is the unfavourable alteration of our surroundings through direct or indirect effects of changes in energy patterns, radiation levels, physical and chemical constitution, abundances of organisms etc. This degradation in turn may have adverse effects on human beings themselves. Pollutants are those substances which are present in the surroundings in such concentrations that they can adversely affect man and his environment. Environmental pollutants include nutrients, acids, toxic elements (including heavy metals), organic compounds, pathogens, particulates, gases, heat, radiation and noise. Among the natural substances that man concentrates in his immediate environment, metals are the most ubiquitous. Metals can neither be degraded nor metabolized.

They are an example of ultimate persistence. Metals enter the living organisms either as inorganic salts or organometallic derivatives. Heavy Metals are defined as all elements except alkali and alkali earth metals. Mercury, lead, cadmium, arsenic etc. re the ones that have severely affected the environment. In the present work, the concentration of Cd (II) has been studied to determine the quality of the aquatic environment such as in river, lakes, sea, tap water and potable water etc.

The experimental technique involves the collection of water samples from different aquatic locations namely, Thane Creek, Mahim Creek, Versova Beach, Masunda Lake, Upvan Lake and Kalu River in a 5 L pre-treated polythene carbouy to avoid contamination. The pH of the solution was dropped to 4. 5 with HNO3 acid and were labelled for identification and stored for further use. A standard calibration curve of Cd (II) was prepared by taking a 2mL aliquot of concentration of 9. 76-48. 8μg/ mL.

1 ml of 1. 39 x 10-3M Alizarin Red S reagent and 0. 5 ml of 0. 05M H2SO4 was added to it. The volume was made up to the mark in a 10 ml standard flask and the absorbance was measured at 422 nm against a corresponding reagent blank on a spectrophotometer.

A graph was plotted of the absorbance vs. μg/ mL. The residue was separated by filtration and 1 L of the filtrate was concentrated nearly to dryness with a mixture of 5 ml of H2SO4 and 10 ml of HNO3. It was further heated till all dense white fumes ceased. 10 ml of water was added and dil. NH4OH was used to neutralize this solution.

1 ml of 2% tartaric acid was used as a masking agent. This solution concentrated to 5mL. The concentration of Cd (II) in the aquatic environmental samples was determined from the standard calibration curve prepared similarly. The residue was also treated identically. The samples were analysed in replicate, accuracy and variation was then determined. The validity of the method was tested on tap water samples spiked with Cd (II).

From the values of Cd (II) obtained by the analysis of water from different sampling sites, it can be concluded that of the locations analysed, Mahim Creek and positions 2 and 3 of Kalu River are polluted with respect to Cd (II). Chapter I Introduction What is Environmental Pollution? Environmental pollution is the unfavourable alteration of our surroundings through direct or indirect effects of changes in energy patterns, radiation levels, physical and chemical constituents, abundances of organisms etc. It is the deterioration of the environment mainly due to human activities. This degradation in turn may have adverse effects on human beings themselves (1). What are Pollutants? Pollutants are those substances which are present in the surroundings in such concentrations that they can adversely affect man and his environment.

Environmental pollutants include nutrients, acids, toxic elements (including heavy metals), organic compounds, pathogens, particulates, gases, heat, radiation and noise. Pollutants may be biodegradable, slowly degradable or non-biodegradable. Bio-degradable pollutants are nutrients and other materials that are easily broken down and absorbed by the environment. Slowly degradable decompose after many years. Non-biodegradable pollutants (chemicals such as polychlorinated biphenyls, dioxins etc.) do not degrade into harmless components.

Some of the natural and man-made degradable substances are not harmful in themselves but can pollute the environment, if they are introduced faster than the rate at which they are removed and may be rendered useless by pollution even before use (e. g. groundwater contaminated by pesticides)(2). Each pollutant has its own origin, pathways and effects, but all pollutants can spread throughout the biosphere through air, land or water. The Major Forms of Pollution: Air Pollution Itis defined as the release of chemicals and particulates into the atmosphere. Common gaseous pollutants include carbon monoxide, sulfur dioxide, chlorofluorocarbons (CFCs), nitrogen oxides, etc.

produced by industry and motor vehicles. Particulate matter or fine dust, is characterized by their micrometre size, PM10 to PM 2. 5 (3). Light Pollution Light pollution is due to excessive or obtrusive artificial light. Pollution is the adding-of/added light itself, in analogy to added sound, carbon dioxide, etc.

Adverse consequences are multiple; some of them may be not known yet. It is the degradation of photic habitat by artificial light. It could also be due to the alteration of natural light levels in the outdoor environment owing to artificial light sources. Indoor light pollution is such alteration of light levels in the indoor environment due to sources of light, which compromises human health (4). Light pollution is the introduction by humans, directly or indirectly, of artificial light into the environment Noise Pollution: Noise pollution is displeasing or excessive noise that may disrupt the activity or balance of human or animal life.

The word noise is cognate with the Latin word nauseas, which means disgust or discomfort [1]. The source of most outdoor noise worldwide is mainly caused by machines and transportation systems, motor vehicles, aircrafts, trains etc. Outdoor noise is summarized by the word environmental noise. Poor urban planning may give rise to noise pollution, since side-by-side industrial and residential buildings can result in noise pollution in the residential areas. It is measured in decibels or db. Indoor noise is caused by machines, building activities, music performances, and especially in some workplaces.

There is no great difference whether noise-induced hearing-loss is brought about by outside (i. e. trains) or inside noise (4). High noise levels can contribute to cardiovascular effects in humans, such as a rise in blood pressure, an increase in stress and vasoconstriction and an increased incidence of coronary artery disease. Radioactive Contamination: Radioactive wastes are wastes that contain radioactive material. Radioactive wastes are usually by-products of nuclear power generation and other applications of nuclear fission or nuclear technology, such as research and medicine.

Radioactive waste is hazardous to most forms of life and the environment, and is regulated by government agencies in order to protect human health and environment. Radioactivity diminishes over a period of time, so waste is typically isolated and stored for a period of time until it no longer poses a hazard. The period of time a waste must be stored depends on the type of waste. Low-level waste with low levels of radioactivity per mass or volume (such as some common medical or industrial radioactive wastes) may need to be stored for only for hours or days while high-level wastes (such as spent nuclear fuel or by-products of nuclear reprocessing) must be stored for a year or more. Current major approaches to managing radioactive waste have been segregation and storage of short-lived wastes, near-surface disposal for low and some intermediate level wastes, and deep burial or transmutation for the high-level wastes(5).

Thermal Pollution: Thermal pollution is the degradation of water quality by any process that changes ambient water temperature. A common cause of thermal pollution is the use of water as a coolant, storm water by power plants and industrial manufacturing. When water used as a coolant is returned to the natural environment at a higher temperature, the change in temperature decreases the oxygen supply, and affects the ecosystem composition. Urban runoff, storm water discharged to surface waters from roads and parking lots can also be a source of elevated water temperatures. When a power plant first opens or shuts down for repair or other causes, fish and other organisms adapted to particular temperature range can be killed by the abrupt change in water temperature known as “ thermal shock”(6). Water Pollution It is a major global problem which requires ongoing evaluation and revision of water resource policy at all levels (international down to individual aquifers and wells).

It has been suggested that it is the leading worldwide cause of deaths and diseases and that it accounts for the deaths of more than 14, 000 people daily. It is estimated that 700 million Indians have no access to a proper toilet, and 1, 000 Indian children die of diarrheal sickness every day. Some 90% of China's cities suffer from some degree of water pollution, and nearly 500 million people lack access to safe drinking water. In addition to the acute problems of water pollution in developing countries, developed countries continue to struggle with pollution problems as well. In the most recent national report on water quality in the United States, 45 % of assessed stream miles, 47 % of assessed lake acres, and 32 % f assessed bays and estuarine square miles were classified as polluted(7).

Water is typically referred to as polluted when it is impaired by anthropogenic contaminants and either does not support a human use, such as drinking water, and/or undergoes a marked shift in its ability to support its constituent biotic communities, such as fish. Natural phenomena such as volcanoes, algae blooms, storms, and earthquakes also cause major changes in water quality and the ecological status of water. Point Source Water PollutionIt refers to contaminants that enter a waterway from a single, identifiable source, such as a pipe or ditch. Examples of sources in this category include discharges from a sewage treatment plant, a factory, or a city storm drain. The U.

S. Clean Water Act (CWA) defines point source for regulatory enforcement purposes. Nonpoint Source Water Pollution It refers to diffuse contamination that does not originate from a single discrete source. NPS pollution is often the cumulative effect of small amounts of contaminants gathered from a large area. A common example is the leaching out of nitrogen compounds from fertilized agricultural lands.

Nutrient runoff in storm water from “ sheet flow” over an agricultural field or a forest is also cited as examples of NPS pollution. Contaminated storm water washed off of parking lots, roads and highways, called urban runoff, is sometimes included under the category of NPS pollution. However, this runoff is typically channeled into storm drain systems and discharged through pipes to local surface waters, and is a point source. Metals Among the natural substances that man concentrates in his immediate environment, metals are the most ubiquitous. Metals can neither be degraded nor metabolized; they are an example of ultimate persistence. Metals enter the living organisms either as inorganic salts or as organmetallic derivatives (8).

Some elements like Fe, Zn, Cu, Co, Cr, Mn, Ni, etc. are needed in small quantities for human metabolism, but may be toxic at higher levels. Others like lead, mercury, cadmium, arsenic etc. ave no beneficial role and are positively toxic. Small amounts of fluoride help to prevent dental caries, but excess is harmful. Toxicity of these is of considerable concern in India because of their environmental burden.

Heavy Metals Heavy metals are defined as all elements except alkali and alkaline earth metals. Amongst the heavy metals, mercury, lead, cadmium, arsenic etc. are the ones that have severely affected the environment. These metals are present in all components of the environment-atmosphere, land and aquatic systems. These elements function at trace levels (trace is defined as the concentration of element less than 100ppm). Heavy metals are pollutants because of their relative high toxicity and persistent nature in the environment.

Therefore, a knowledge of the changing concentrations and distribution of heavy metals and their compounds in various compartments of the environment is a priority for good environmental management programmes all over the world(9)Figure 1. Process of introduction of heavy metals into the environment. The enrichment of heavy metal in the environment can result from both anthropogenic activities and natural processes. As long as human-induced generation of heavy metals continues in industrial and domestic activities, sustained measurements will be needed to assess the effectiveness of set limitation standards and facilitate the identification and quantification of the state of environmental degradation attributable to the discharged heavy metals. Contaminating elements and compounds are transported by water and gather in the bottom and alluvial sediments. Thus there has been growing concern in recent years that certain anthropogenic trace metals released by industries and domestic effluents are incorporated into urban water bodies and quickly find themselves circulating in drinking water pools.

Many of these elements being stable are bio-accumulative, and deriving their safe limits is very difficult. Also, the toxicity of metals depend largely on their chemical form and oxidation states. Hence, toxicity studies without taking speciation into consideration may not reveal its actual hazard. Minamata Disease The focus on environmental pollution began with the Minamata

Disease Figure 2. Woman with a severe form of ataxia due to mercury poisoning. Minamata disease, sometimes referred to as Chisso-Minamata disease, is a neurological syndrome caused by severe mercury poisoning.

Symptoms include ataxia, numbness in the hands and feet, general muscle weakness, narrowing of the field of vision and damage to hearing and speech. In extreme cases, insanity, paralysis, coma and death follow within weeks of the onset of the symptoms. A congenital form of the disease can also affect foetuses. Minamata disease was first discovered in Minamata City in Kumamoto prefecture, Japan in 1956. It was caused by the release of methylmercury into the industrial wastewater (point source pollution) from the Chisso Corporation's chemical factory, which continued from 1932 to 1968.

This highly toxic chemical bioaccumulated in shellfish and fish in Minamata Bay and the Shiranui Sea, which when eaten by the local populace resulted in mercury poisoning. While cat, dog, pig and human deaths continued over more than 30 years, the government and company did little to prevent the pollution. As of March 2001, 2, 265 victims had been officially recognized (1, 784 of whom had died) and over 10, 000 had received financial compensation from Chisso. By 2004, Chisso Corporation had paid $86 million in compensation, and in the same year was ordered to clean up its contamination. Lawsuits and claims for compensation continue to this day. A second outbreak of Minamata disease occurred in Niigata Prefecture in 1965.

Both the original Minamata disease and Niigata Minamata disease are considered two of the Four Big Pollution Diseases of Japan. Cadmium

Cadmium is a heavy metal with a high toxicity. Cadmium is toxic at very low exposure levels and has acute and chronic effects on health and environment. Cadmium is not degradable in nature and will thus, once released to the environment, stay in circulation. New releases add to the already existing deposits of cadmium in the environment.

Cadmium and cadmium compounds, compared to other heavy metals, are relatively water soluble. They are therefore also more mobile e. g. soil, thus are generally more bioavailable and tend to bioaccumulate. Chronic cadmium exposure produces a wide variety of acute and chronic effects in humans. Cadmium accumulates in the human body and especially in the kidneys.

According to the current knowledge kidney damage (renal tubular damage) is probably the critical health effect. Other effects of cadmium exposure are disturbances of calcium metabolism, hypercalciuria and formation of stones in the kidney etc. High exposure can lead to lung cancer and prostate cancer (10). The major issues of concern related to cadmium may be due to the atmospheric deposition which seems to continuously cause the content of cadmium in agricultural top soil to increase, which by time it will be reflected in an increased human intake by foodstuffs and therefore in an increased human risk of kidney damages and other effects related to cadmium. In the marine environment, levels of cadmium may significantly exceed background levels causing a potential for serious effects on marine animals and in particular birds and mammals.

Significant quantities of cadmium are continuously stockpiled in landfills and other deposits and represent a significant potential for future releases to the environment. The dominant sources of atmospheric emission will vary depending on the region or country considered. Non-ferrous metal production as well as combustion of coal and oil and waste incineration should be considered important sources. Important sources of cadmium input to the marine environment include atmospheric deposition, domestic waste water and industrial discharges. Itai-Itai DiseaseItai-Itai disease was the documented case of mass cadmium poisoning in Toyama Prefecture, Japan, starting around 1912.

The cadmium poisoning caused softening of the bones and kidney failure. The disease is named for the severe pains caused in the joints and spine. The term “ itai-itai disease” was coined by the locals. Cadmium was released into rivers by mining companies in the mountains. The mining companies were successfully sued for the damage. ‘ itai-itai’ disease is known as one of the Four Big Pollution Diseases of Japan.

Cause Itai-Itai disease was caused by cadmium poisoning due to mining in Toyama Prefecture. The earliest records of mining for gold in the area date back to 1710. Regular mining for silver started in 1589, and soon thereafter, mining for lead, copper and zinc began. Increased demand for raw materials during the Russo-Japanese War and World War I, as well as new mining technologies from Europe, increased the output of the mines, putting the Kamioka Mines in Toyama among the world’s top mines. Production increased even more before World War II.

Starting in 1910 and continuing through 1945. Cadmium was released in significant quantities by mining operations, and the disease first appeared around 1912. Prior to World War II the mining was controlled by the Mitsui Mining and Smelting Co. , Ltd. which increased to satisfy the wartime demand. This subsequently increased the pollution of the Jinzu River and its tributaries.

The river was used mainly for irrigation of rice fields, but also for drinking water, washing, fishing, and other uses by downstream populations. Due to the cadmium poisoning, the fish in the river started to die, and the rice irrigated with river water did not grow well. The cadmium and other heavy metals accumulated at the bottom of the river and in the water of the river. This water was then used to irrigate the rice fields (11). The rice absorbed heavy metals, especially the cadmium. The cadmium accumulated in the people eating contaminated rice.

The population complained to the Mitsui Mining and Smelting about the pollution. The company built a basin to store the mining waste water before leading it into the river. It was too little, too late as many people were already sick. The causes of the poisoning were not well understood up to 1946, it was thought to be simply a regional disease or a type of bacterial infection. Medical tests started in the 1940s and 1950s, searching for the cause of the disease. Initially, it was expected to be lead poisoning due to the lead mining upstream.

Only in 1955 did Dr. Hagino and his colleagues suspect cadmium as the cause of the disease. Toyama prefecture also started an investigation in

1961, determining that the Mitsui Mining and Smelting's Kamioka Mining Station caused the cadmium pollution and that the worst affected areas were 30 km downstream of the mine. In 1968 the Ministry of Health and Welfare issued a statement about the symptoms of ‘ itai-itai’ disease caused by the cadmium poisoning. The reduction of the levels of cadmium in the water supply reduced the number of new disease victims; no new victim has been recorded since 1946.

While the victims with the worst symptoms came from Toyama prefecture, the government found victims in five other prefectures. The mines are still in operation and cadmium pollution levels remain high, although improved nutrition and medical care has reduced the occurrence of ‘ itai-itai’ disease Symptoms One of the main effects of cadmium poisoning is weak and brittle bones. Spinal and leg pain is common, and a waddling gait often develops due to bone deformities caused by cadmium. The pain eventually becomes debilitating, with fractures becoming more common as the bone weakens. Other complications include coughing, anaemia, and kidney failure, leading to death.

A marked prevalence in older, postmenopausal women has been observed. The cause of this phenomenon is not fully understood, and is currently under investigation. Current research has pointed to general malnourishment, as well as poor calcium metabolism relating to the women's age. Recent animal studies have shown that cadmium poisoning alone is not enough to elicit all symptoms of ‘ itai-itai’ disease. These studies are pointing to the damage of the mitochondria of kidney cells by cadmium as a key factor of the disease.

Figure 3. Bone deformation seen in an itai-itai victim. Twenty-nine plaintiffs, consisting of nine victims and 20 family members of victims, sued the Mitsui Mining and Smelting Co. in 1968 in the Toyama Prefectural court. In June 1971, the court found the Mitsui Mining and Smelting Co. guilty.

Subsequently, the company appealed to the Nagoya District Court in Kanazawa, but the appeal was rejected in August 1972. The Mitsui Mining and Smelting Co. greed to pay for the medical care of the victims; finance the monitoring of the water quality performed by the residents; and pay reparations to the victims of the disease. People who consider themselves victims of ‘ itai-itai’ disease had to contact the Japanese Ministry of Health, Labor and Welfare to have their claims assessed. Many victims were not satisfied with government actions and demanded a change in the official procedures. This caused the government to review the criteria for recognizing a victim legally; the government also reassessed the treatment of the disease.

A person is considered to have ‘ itai-itai’ disease if he or she lived in the contaminated areas, had kidney dysfunctions, softening of the bones, but not related heart problems. One hundred eighty-four victims have been legally recognized since 1967, of whom 54 were recognized in the period from 1980 to 2000. An additional 388 people have been identified as potential victims, those that had not been officially examined yet. Fifteen victims were still alive as of 1993. Economic Costs The cadmium pollution had contaminated many agricultural areas. Heavy metal pollution affected many areas in Japan, and as a result the Prevention of Soil Contamination in Agricultural Land Law of 1970 was enacted.

It ordered planting to be stopped so that restoration of the soil could be enacted to areas with 1ppm of cadmium or more contamination in the soil. Surveying in Toyama Prefecture began in 1971, and by 1977, 1500 hectares along the Jinzu River were designated for soil restoration. These farmers were compensated for lost crops as well as for lost production in past years by the Mitsui Mining and Smelting, Toyama Prefecture, and the national government. As of 1992, only 400 hectares remained contaminated. In 1992, the average annual health expense compensation was ? 743 million. Agricultural damage was compensated with ? 1.

75 billion per year, or a total of annually ? 2. 518 billion. Another ? 620 million were invested annually to reduce further pollution of the river. On 17 March 2012, officials concluded that in the cleanup project of the cadmium-polluted areas in the Jinzu River basin. 863 hectares of topsoil had been replaced, since the cleanup began in 1979 at a total cost of ? 40. 7 billion.

The project had been financed by the Japanese national government, Mitsui Mining, and the Gifu and Toyama prefectural governments(7). Sources of Cadmium Cadmium is released into the biosphere from both natural and anthropogenic sources. Natural Sources The major natural sources for mobilisations of cadmium from the earth’s crust are volcanoes and weathering of rocks. The weathering of rocks releases cadmium into soils and aquatic systems. This process plays a significant role in the global cadmium cycle, but only rarely results in elevated concentrations in any environmental compartment. Within the biosphere, the cadmium is translocated by different processes.

The major sources for emission to air from natural sources are volcanoes, airborne soil particles, sea spray, biogenic material and forest fires. Total emission to air from natural sources are estimated at about 150-2, 600 tonnes; these figures may be compared to an estimated total global anthropogenic air emission in 1995 of approximately 3, 000 tonnes. Anthropogenic Sources Tonnes of cadmium is extracted from the earth’s crust by man and brought into circulation in the technosphere. Beside this, a significant amount of cadmium ended up in metal extraction residues or was mobilised as impurity by extraction of other minerals like coal and lime. The general trend in the global cadmium pollution over the last two decades has been a steep increase due to the use of cadmium for batteries and a decrease in the use for nearly all other applications. Batteries accounted in 1990 for 55% of the total Western World consumption.

The use of cadmium for pigments, PVC stabilisers and plating in some countries by and large has been phased out. The largest contributors to the contamination of water are mines (mine water, concentrate processing water, and leakages from mine tailings) as seen with the ‘ itai-itai’ disease; process water from smelters; phosphate mining and related fertilizer production; and electroplating wastes. The largest sources of cadmium in landfills are smelters, iron and steel plants, electroplating wastes, and battery production. Mine tailings generated as a result of zinc mining also have the potential to transfer cadmium to the ambient environment.

Cadmium is mainly used as an anticorrosion coating in electroplating, as an alloying metal in solders, as a stabilizer in plastics (organic cadmium), as a pigment, and as a component of nickel-cadmium batteries. Cadmium production may use by-products and wastes from the primary production of zinc.

Figure 4. Cadmium pathways during mining to end use and disposal Release of Cd into the Water Environments Major sources of Cadmium pollution in water bodies were domestic wastewater, non-ferrous metal smelting and refining, and manufacturing of chemicals and metals. Cadmium levels of up to 5 mg/kg have been reported in sediments from river and lakes, and from 0. 03 – 1 mg/kg in marine sediments. The average cadmium content of seawater is about 5-20 µg/l in open seas. Food and Drinking Water Cadmium contained in soil and water can be taken up by certain crops and aquatic organisms and accumulate in the food-chain.

Food constitutes the main environmental source of cadmium for non-smokers. Highest cadmium levels are found in the kidney and liver of mammals fed with cadmium-rich diets and n certain species of oysters, scallops, mussels and crustaceans. Lower cadmium concentrations are found in vegetables, cereals and starchy roots. Owing to the large consumption of such food items, they represent the greater part of daily cadmium intake in most populations. Some crops, such as rice, can accumulate high concentrations of cadmium if grown on cadmium-polluted soil.

Acidification of cadmium-containing soils may increase the cadmium concentrations in crops. Cadmium exposure from drinking-water is relatively unimportant compared with exposure from the diet. However, impurities of zinc in the galvanized pipes and solders in fittings, water heaters, water coolers and taps can sometimes lead to increased cadmium levels in drinking-water (12). Smoking The tobacco plant naturally accumulates relatively high concentrations of cadmium in its leaves. Thus, smoking tobacco is an important source of exposure, and the daily intake may exceed that from food in case of heavy smokers. Cigarette smoking can cause significant increases in the concentrations of cadmium in the kidney, the main target organ for cadmium toxicity.

LimitsIn general, the amount of cadmium that will cause health problems will vary depending on: (1) The type of exposure (eating or breathing), (2) The duration of the exposure (short- or long term), (3) The form of cadmium (pure cadmium or some combination). Humans that eat or drink cadmium contaminated food and water for a short period of time (less than 14 days) in amounts of 0. 05 milligrams per kilogram of body weight per day (mg/kg/day) can experience stomach irritation. Long-term exposure (greater than 14 days) in amounts of 0. 005 mg/kg/day cause relatively little risk of injury to the kidney or other tissues.

Exposure to cadmium Figure 5. Drinking water limits across the globe through food is typical for most people but is not a major health concern. This is because the cadmium present in the body from our diet is about 0. 0004 mg/kg/day. This figure is about ten times lower than the level of cadmium that causes kidney damage from eating contaminated food. The average cadmium content of seawater is about 5-20 µg /L in open seas and the USEPA has termed this as a safe upper limit for marine life with respect to Cd (II).

13 In 1974, Congress in the U. S. passed the Safe Drinking Water Act. This law requires EPA to determine the level of contaminants in drinking water at which no adverse health effects are likely to occur. These non-enforceable health goals, based solely on possible health risks and exposure over a lifetime with an adequate margin of safety, are called maximum contaminant level goals (MCLG).

Contaminants are the physical, chemical, biological or radiological substances or matter in water (13). The MCLG for cadmium is 5 ppb. EPA has set this level of protection based on the best available science to prevent potential health problems. EPA has set an enforceable regulation for cadmium, called a maximum contaminant level (MCL), at or 5 ppb. Health Effects Ingestion via food, especially plant-based foodstuffs, is the major route by which cadmium enters the human body from the environment.

Average human daily intake of cadmium from food has been estimated at around 10–50 ? g. This may increase to several hundred micrograms per day in polluted areas. The intake of cadmium through inhalation is generally less than half that via ingestion, while daily intake from drinking water ranges from below 1 ? g to over 10 ? . The kidney, especially the renal tract, is the critical organ of intoxication after exposure to cadmium. Excretion is slow and renal accumulation of cadmium may result in irreversible impairment in the reabsorption capacity of renal tubules.

Only a small proportion (5–10%) of ingested cadmium is absorbed by humans and large variations exist among individuals. Severe renal dysfunction and damage to the bone structure have been associated with long-term exposure to cadmium in food (mainly rice) and water in Japan documented through the itai-itai disease as mentioned before. WHO estimated that long-term daily ingestion of 200 ? g of cadmium via food can be connected with 10% prevalence of adverse health effects. Deficiencies of iron, zinc, and calcium in the human body generally facilitates cadmium absorption. Since most crops, with the exception of rice, contain zinc that inhibits the uptake of cadmium by animals and humans, there is no scientific proof that populations in general are at risk of cadmium exposure via the food chain(14).

Animal studies have yielded sufficient evidence of the carcinogenicity of cadmium in animals. Limited evidence of human carcinogenicityis also available in studies linking long-term occupational exposure to cadmium, to increased occurrence of prostate and lung cancer cases. USEPA estimated the incremental cancer risk from continuous lifetime exposure to 1 ? g/m3 concentrations to be 0. 0018. Environmental Pollution in India India is among the world’s worst performers when it comes to the overall environment. We rank 125 of 132 countries.

Even Pakistan and Bangladesh are less polluted than we are. A study released earlier this year by the environmental research centres of Columbia and Yale showed that India was at the bottom of the heap when it came to air pollution. In India the increasing economic development and a rapidly growing population that has taken the country from 300 million people in 1947 to more than one billion people today is putting a strain on the environment, infrastructure, and the country's natural resources. Industrial pollution, soil erosion, deforestation, rapid industrialization, urbanization, and land degradation are all worsening the problems. Overexploitation of the country's resources, be it land or water and the industrialization processes have resulted in environmental degradation of resources. Environmental pollution is one of the most serious problems facing humanity and other life forms on our planet today.

Environmental degradation has become a major societal issue thanks to the uncontrolled anthropogenic activity, besides natural factors. Entry of toxic heavy metals and minerals in human system, mainly through contaminated water, food, and air, leads to overt and insidious health problems. A rapidly developing country like India needs to be aware of these problems and find preventive and remedial solutions for management. Sometimes expensive high-tech remedial measures are not easy for a country like India, and hence emphasis has to be on cost effective diagnostics and prevention. River Water Pollution Contaminated and polluted water now kills more people than all forms of violence including wars, according to a United Nations report released on March 22, 2010 on World Water Day.

It calls for turning unsanitary astewater into an environmentally safe economic resource. 90 % of wastewater discharged daily in developing countries is untreated, contributing to the deaths of some 2. 2 million people a year from diarrheal diseases caused by unsafe drinking water and poor hygiene. At least 1. 8 million children younger than 5 die every year from water-related diseases. Fully 80 % of urban waste in India ends up in the country’s rivers, and unchecked urban growth across the country combined with poor government oversight means the problem is only getting worse.

A growing number of bodies of water in India are unfit for human use, and in the River Ganga, holy to the country’s 82 % Hindu majority, is dying slowly due to unchecked pollution. New Delhi’s body of water is little more than a flowing garbage dump, with fully 57 % of the city’s waste finding its way to the Yamuna. Three billion liters of waste are pumped into Delhi’s Yamuna (River Yamuna) each day. Only 55 % of the 15 million Delhi residents are connected to the city’s sewage system. The remainder flush their bath water, waste water and just about everything else down pipes and into drains, most of them empty into the Yamuna.

According to the Centre for Science and Environment, between 75 and 80 % of the river’s pollution is the result of raw sewage. Combined with industrial runoff, the garbage thrown into the river and it totals over 3 billion liters of waste per day. Nearly 20 billion rupees, or almost US $500 million, has been spent on various clean-up efforts. Much of the river pollution problem in India comes from untreated sewage. Samples taken recently from the Ganges River near Varanasi show that levels of faecal coliform, a dangerous bacterium that comes from untreated sewage, were some 3, 000 % higher than what is considered safe for bathing(5). Groundwater Exploitation Groundwater Quality and Pollution is the most alarming pollution hazards in India.

On April 01, 2010 at least 18 babies in several hamlets of Bihar's Bhojpur district were born blind in the past three months because their families consumed groundwater containing alarming levels of arsenic, confirmed by Bihar's Health Minister Nand Kishore Yadav on Wednesday, 31st March 2010. He confirmed the case of blindness in new-borns was due to arsenic-affected blocks of the district. According to the World Health Organization on World Water Day 2012, on March 22 each year, an estimated four billion people get sick with diarrhea as a result of drinking unsafe water, inadequate sanitation, and poor hygiene. Improper disposal of solid waste, both by the public and Bruhat Bangalore Mahanagara Palike (BBMP) is causing direct contamination of groundwater, according to Dr M A Farooqui, scientist, Central Ground Water Board (CGWB)(3). Pollution of Indian SeasTwo merchant vessels — MSC Chitra and Khalijia-III collided off the Mumbai coast on August 7, 2010 causing an oil spill. Several containers from one of the vessels fell into the sea.

Nearly 100 containers that fell into the waters following the collision between two merchant vessels off the Mumbai coast and are still missing and two of them are carrying hazardous chemicals reported on August 17, 2010. Mumbai The problem of water quality degradation due to toxic heavy metals has begun to cause concern in most of the major metropolitan cities in Maharashtra and Mumbai is not an exception to it. The day by day deteriorating quality of water bodies in the country is of great concern and hence it is necessary to carry out a prompt, systematic and detailed study of pollution due to toxic heavy metals in water bodies around Mumbai, which due to rapid urbanisation and industrialisation is considered as one of the highly pollutable locations in the world. Business and industrial hubs around the city have further resulted in discharge of solid waste, organic waste, industrial waste, heavy metals, oils and tar into the neighbouring water bodies. Mumbai has a thick density of population.

The organic waste, sludge and garbage dumping have severely deteriorated the quality of water in large bodies around Mumbai. The average Cd concentration was found to be 40, 34 and 72 ? g/L respectively at different sampling stations in Mithi River in an independent study 16. Water Supply The water supply to Bombay from various sources is about 563 million gallons per day (MGD). The monsoon precipitation is collected in six lakes and supplied to the city through the year. 460 MGD are treated at the Bhandup Water Treatment Plant, the largest in Asia. The BMC manages to supply between 70 and 75% of the city's water needs.

The water distribution system in Bombay is about 100 years old. Water is brought into the city from the lakes after treatment, and stored in 23 service reservoirs. Since two of the major sources, Tansa and Lower Vaitarna, are at a higher level than the city, not much power is required to pump the water. The service reservoirs are mainly situated on hills. Some of them are located at Malabar Hill, Worli Hill, Raoli, Pali Hill, Malad, Powai and Bhandup. Timings of water supply to different parts of the city vary between 2 and 5 hours.

Owing to this complexity, contamination due to various pollutants especially a heavy metal like Cd, constitutes a major risk. Chapter II Aim ; amp; Objectives Aim A Study of Heavy Metal Pollution (Cadmium) in the Aquatic Environment of Mumbai by Spectrophotometric Method Objectives It is apparent that heavy metals play a very important role in environmental pollution and require monitoring of the levels for safety purposes. As most of these pollutants are in the µg or ng range hence, a very sensitive and selective method such as spectrophotometric method using alizarin red S reagent was employed for the determination of heavy metal such as Cd (II) in aquatic environment of Mumbai. Any monitoring requires an assessment of the quality of the environment. In the present work the concentration of the heavy metal such as Cd (II) in the aquatic environment such as the lakes, rivers, sea, tap water, potable water etc.

in Mumbai has been determined by spectrophotometric method employing Alizarin red S. Each of the following locations were analysed for Cd (II) at 3 different positions in triplicate: Thane Creek Mahim Creek Versova Beach Masunda Lake Upvan Lake Kalu River Tap and potable water samples were also analysed. A standard calibration curve of Cd (II) vs. µg/ mL was prepared by measuring absorbance at 422 nm. The results of the analysis of Cd (II) concentration in the water samples are discussed with reference to the pollution of the aquatic environment and compared with the permissible levels. The validity of the method was evaluated on tap water spiked with a known amount of Cd (II) and the recovery was found to be quantitative.

The data has been analysed statistically Chapter III Materials ; amp; Method Chemicals and Reagents All the chemicals and reagents used were of A. R. or G. R. grade and used without further purification. Glasswares All the glasswares used for the experimental work were made of Corning or Borosil glass.

Burettes, pipettes and standard measuring flasks were calibrated by the standard method given in Vogel (1). Preparation of Double Distilled Water Double-distilled water was prepared by distilling deionized water in an all glass apparatus containing KMnO4 and a pallet of NaOH. Balance A single-pan digital analytical balance having sensitivity of 0. 001 g of Contech make, CA-123 series was used for weighing chemicals, reagents and samples. Spectrophotometer The analysis of all samples was carried out on a visible spectrophotometer of SYSTRONICS make, model no.

166. Sample Collection: 5 L carbuoys were washed with conc. HNO3, tap water, distilled water and double-distilled water to remove surface contamination, kept carefully to prevent pre-collection contamination and labelled for identification. Locations of Collection: Samples of water were collected from the surface at the following locations in pre-treated 5 L carbuoys at 3 different positions: Thane Creek Mahim Creek Versova Beach Masunda Lake Upvan Lake Kalu River Tap and potable water samples were also collected. After receiving the samples in the laboratory the pH of the water was checked and HNO3 was added to drop the pH to 4.

5. They were then labelled for identification and kept in storage until further use. Preparation of Standard Cd (II) Solution: 1. 63g of cadmium chloride of A. R.

rade was dissolved in 100 mL of double distilled water containing 5 mL of HNO3 to give a solution of approximately 10mg/mL Cd (II). It was estimated by the quinaldic acid method as give below. (1) An aliquot of the solution containing Cd (II) was heated to boiling and then the source of heat was removed. A 3. 3% solution of quinaldic acid was added drop-wise to this solution and stirred vigorously until it was present in slight excess. It was neutralised carefully with 1: 1 NH4OH and the curdy white precipitate so formed was allowed to settle.

The precipitate was cooled, decanted and filtered through a sinterbed G4 crucible. It was further washed repeatedly with double distilled water, dried at 110°C in an oven, cooled in a decicator and weighed to a constant weight as Cd (C10. H6O2N) 2 Results of analysis in triplicate gave a concentration of the Cd (II) solution of 9. 76 mg/mL. Alizarin Red S Solution: 50mg of alizarin red S. was dissolved in a 100 mL of double distilled water to give a molar concentration of 1.

39 X 10-3M. Thane Creek Mahim Creek Versova Beach Masuda Lake Upvan Lake Kalu River Preparation of Calibration Curve of Cd (II) Spectrophotometrically Using Alizarin Red S: To a 2. mL of a neutral aqueous (pH 6) solution containing 9. 76-48. 8 μg of Cd (II) was taken in a 10 mL standard measuring flask and mixed with 1mL of the alizarin red S reagent solution of 1. 39 X 10-3M.

0. 5 mL of 0. 05 M sulfuric acid was also added. This solution was diluted to the mark with double distilled water. The absorbance was measured at 422 nm against a corresponding reagent blank. The Cd (II) content in the water samples and residue was determined using a concurrently prepared calibration graph of concentration of Cd (II) in μg/mL vs.

absorbance (2). Processing of the Aquatic Samples for the Estimation of Cd (II)The water samples that were collected for the determination of Cd (II) were first filtered to remove the insoluble residue if present. The separation was carried out by filtering 5 L of the water sample through a Whatman no. 41 filter paper and the filtrate was collected in another carbuoy. 1 L of this solution was concentrated to 25 mL and treated with a mixture of 5 mL of H_2SO_4 and 10 mL of HNO_3.

This solution was the heated nearly to dryness after which 10mL of double distilled water and dil. NH_4OH was added to neutralize it. 1 mL of 2% tartaric acid was added as a masking agent. This solution was further concentrated to approximately 5 mL and quantitatively transferred to a 10 mL standard flask. 1 mL of Alizarin Red S.

of 1. 39 X 10-3M and 0. 5 mL of 0. 05M $H_2SO_4$was added. The solution was made up to the mark and the absorbance was measured at 422nm against a corresponding reagent blank. The concentration of Cd (II) was calculated using the calibration curve similarly prepared as mentioned above.

Treatment and Estimation of Cd (II) in Residue The residue remaining after filtration was dissolved in HNO_3 and treated in a similar manner to that mentioned for the filtrate.