Chapter 1 : Fact Sheet Mercury Update: Impact on Fish Advisories

Mercury Pollution Integration and Synthesis - CRC Press Book This book contains 57 chapters describing the results of original research and reviewing the state-of-the-science with respect to environmental mercury.

Received Jan 13; Accepted Jun This article has been cited by other articles in PMC. Abstract The study investigations were focused on assessing the influence of a year-old municipal waste landfill on environmental mercury pollution. The total Hg content was determined in the soil profile, groundwater, and the plants Solidago virgaurea and Poaceae sp. Environmental pollution near the landfill was relatively low. The topsoil layer, groundwater and the leaves of Solidago virgaurea and Poaceae sp. The total Hg content in the soil decreased with the depth. The results are presented as pollution maps of the landfill area based on the total Hg content in the soil, groundwater and plants. Statistical analysis revealed the lack of correlation between the total Hg content in the soil and plants, but a relationship between the total concentration of Hg in groundwater and soil was shown. The landfill is not a direct source of pollution in the area. The type of land morphology did not influence the pollution level. Construction of bentonite cut-off wall bypassing MSW landfill reduces the risk of mercury release into ground-water environment. Introduction Mercury is a global contaminant posing severe risks to the health of ecosystems and humans worldwide. The environmental contamination of land, air, water, and wildlife in various ecosystems with Hg around the world due to the natural release and extensive anthropogenic use of Hg has been a global concern for decades [1]. Global emissions of Hg in from landfills and waste utilization are estimated at Mg, which is 8. However, the estimate from this sector exhibits large uncertainties due to the lack of field measurement data [2]. India produces the most Hg, with a measurement of Landfilling remains the predominant management method for the disposal of municipal solid waste MSW in Poland. Used batteries, electric equipment, lighting equipment, control-measuring devices, mercury amalgams and used paint tins are common items in municipal waste landfills [7]. Wastes containing Hg that are deposited in landfills may become long-term sources of environmental pollution to the air, water and land through leaching [8]. The Hg content in municipal wastes is difficult to determine. Hg is occasionally recovered from waste, but this is often financially inviable. Concentration of Hg in municipal landfill can range from 0. Intense source reduction efforts have been implemented to reduce the Hg content in municipal waste landfills, resulting in a rapidly declining trend from 1. However, the increasing quantities of MSW generated by society constantly adds to increasing the Hg load into landfills. Landfill leachate contains a variety of pollutants that may potentially contaminate the groundwater and affect the quality of surface and well waters. Concentration of Hg in a municipal waste landfill leachate can range from 0. Despite numerous reports devoted to municipal waste management and the resulting hazards, the actual influence of such objects on the basic elements of the environment water, soil, plants is still not fully known [6], [16]. Hg properties, such as toxicity, mobility and ability to migrate over large distances, require continuous monitoring of the concentration of this metal, particularly in the vicinity of locations commonly considered as potential sources of pollution by Hg e. The current study focuses on the influence of a municipal waste landfill on the pollution of basic elements of the natural environment, i. The working hypothesis is that Hg concentration in particular components of the environment increase according to the groundwater flow. Materials and Methods No specific permissions were required for the study area. The field studies did not involve endangered or protected species. Specific location of study: Two major geomorphological formations have been distinguished:

Chapter 2 : An overview of mercury contamination research in the Amazon basin with an emphasis on Bra

Note: Citations are based on reference standards. However, formatting rules can vary widely between applications and fields of interest or study. The specific requirements or preferences of your reviewing publisher, classroom teacher, institution or organization should be applied.

The assessment was based on an extensive and systematic review using bibliographic databases available online and a review of projects by research groups. A geographic information system was used to determine the location of the studies. Different aspects of mercury contamination were evaluated environmental studies, impacts on human health, technological improvements. For , a total of publications were identified. The main advances and remaining gaps in relation to environmental issues and human health were identified and discussed. Although the scientific output varied considerably over the period, there was a general increase in the total number of publications per year from the early s fewer than 20 until more than 30 , considering the articles published in indexed journals. In almost all the countries in the Amazon basin, mercury Hg was used in the gold extraction process. Concerns regarding mercury contamination in the Amazon Basin were first raised in the early s, when studies emphasized that significant amounts of the metal were being dumped into the Amazonian ecosystem as a result of this "gold rush" 1,2,3,4,5,6,7,8,9. Fat solubility of mercury compounds means that higher predators present the greatest Hg levels, due to biomagnification along the food chain 11,12, Consumption of aquatic organisms contaminated with mercury is the main exposure route for humans 14,15, High mercury levels were found in the Brazilian Amazon ecosystems, attributed initially to gold mining activities only 17,18,19,20, However, some authors later suggested that Amazonian soils have high natural mercury concentrations that could explain the Hg levels measured in fish and humans in the region 22,23, Other authors hypothesized that atmospheric transport of anthropogenic mercury might account for the widespread contamination of the Amazon basin 25,26,27, In addition, deforestation for cattle-raising and agriculture occurred at high rates since the early s, increasing the soil erosion and probably contributing directly and indirectly to mercury dispersion. Moreover, large reservoirs formed for hydroelectric power generation in the Brazilian Amazon favored mercury mobilization and methylmercury production 29, Some Amazonian riverine populations have high hair mercury levels, attributed to a diet based on fish, the main source of protein 31,32,33,34,35,36,37,38,39, However, given the amount of mercury already present in the Amazon ecosystem and its persistency, this approach must be viewed as a long-term mitigation plan. Mercury has been recognized as a significant public health problem for more than 40 years, due mainly to its effects on the developing nervous system, as expressed in the tragic cases of human poisoning in Japan and Iraq. The effects included mental retardation, cerebral palsy, deafness, blindness, and dysarthria in individuals who were exposed in uterus, and sensory and motor impairment in exposed adults. Chronic low-dose prenatal methylmercury exposure from maternal consumption of fish has been associated with more subtle endpoints of neurotoxicity in children 41,42,43,44,45, There is also evidence in humans and animals that exposure to methylmercury can lead to adverse effects on the developing and adult cardiovascular system 47, Many researchers have observed that there is no noticeable acute sign of contamination in humans in the Amazon basin. However, a few researchers have analyzed the neurological effects of low mercury exposure. The authors suggest a risk of neurological disorders, and that some neurotoxic alterations of motor functions can be detected even below the threshold value of 50ppm in hair set by the World Health Organization However, the effects on humans, especially neurotoxicity in traditional populations, remain to be understood, as do the ecological impacts of methylmercury on Amazonian wildlife. This paper presents a literature review on mercury contamination in the Amazon Basin and its evolution over time. The assessment is based on an extensive and systematic review of research projects and scientific data produced from to It includes dissertations, theses, articles, reports, and books. The evolution in approaches used in the studies was also reviewed. The main achievements and remaining gaps in knowledge on environmental issues and health impacts on humans were identified and discussed. Methodology A systematic and extensive review of electronic databases was performed using specific key words to identify studies on mercury contamination in

the Amazon basin, from to Researchers and research groups involved in this issue were also identified and organized as a function of different aspects of their work, including topics, methodologies, and geographic location. Searches were conducted in Spanish, English, and Portuguese in the following bibliographic databases available on the Internet: National Library of Medicine Gateway http: The collected data were filtered and organized to answer four main questions: A geographic information system GIS was used to answer question 2. If geographic coordinates were available, they were recorded; otherwise, a complex geocoding strategy was carried out to recover the locations mentioned. We verified the correct position of these sites by pinpointing them on a digital map, which contained reference layers such as rivers, cities, villages, indigenous communities and reserves, and municipal or county limits. If the description of the research site differed from that verified, a second strategy was applied, consisting of retrieving maps published in the selected articles. The maps allowed recognizing topographic references like rivers, lakes, and villages and pinpointing the site on the reference map. Finally, the fourth strategy identified the names of rivers and lakes cited in the paper on the reference digital map. Since rivers are often used as the main form of access to fieldwork in the Amazon and also represent the main transportation and cycling pathway for mercury, these waterways are frequently cited in the publications. Since all these spatial units have large dimensions in the Amazon e. Using this procedure, the positioning error of some sites is estimated at 30km, which is compatible with the original scale of the reference map 1: In order to establish the profile of the research groups and individual researchers working in the Amazon, specific Brazilian databases like the Brazilian Directory of Research Groups of the National Research Council CNPq; http: The CNPq censuses of research groups were started in and now include most active Brazilian researchers These databases list the researchers, staff, and students in each group, their respective research subjects, and the main scientific area. Key words were used to identify research groups in different fields e. Some groups may not appear because they perform research on mercury contamination in the Amazon but not exclusively in this region and they did not use "Amazon" as a key word in their research results rather, for example, mercury and "tropical ecosystems". While admitting the possible limitations of this approach, the methodology was applied to each CNPq census , , , , , and In addition, Brazilian Federal and State research funding agency databases were examined to identify the funding allocated to the study of mercury contamination in the Amazon. Besides Brazilian research groups, these databases also allowed identifying cooperation with foreign groups. Although groups from other Amazonian countries are involved in mercury research, organized databases could not be identified and these researchers could not be included in this paper. The documents analyzed in this review were mostly articles from scientific journals that are indexed in international or national databases. There are two main reasons: Scientific journals are published much more quickly than books and reports, so their data tend to be the most up-to-date available. In addition, scientific journals usually use peer reviewing, the main mechanism for assuring quality of information. Abstracts and other documents with less than two pages, as well as documents with unidentified authors or institutions, were not included. Most of the data were collected from electronic sources. Access to the full text was fundamental in order to depict parameters like type of study, matrices, etc. However, for specific analyses e. The set of information collected in the texts was carefully organized in a spreadsheet, allowing a complete set of statistical analyses. Results and discussion From to , a total of publications on mercury contamination in the Amazon Basin were identified, including 42 theses and dissertations, 28 reports, 19 books, articles published in scientific journals, and 43 extended abstracts presented at scientific meetings Figure 1. There was a peak in the year 50 references , and a slight decrease in the last two years 25 and 27, respectively. Concerning question 1, few research institutions were working with mercury contamination in the Amazon in the early s. Important international cooperation only began in the following decade. Figure 2 shows the predominance of Brazilian research groups as compared to those from other Amazon basin countries: The remaining countries produced only one publication during this period. The presence of research groups from different Amazonian countries began in and slowly increased in the later years of the period analyzed. Brazilian research institutions produced the most publications based on international cooperation between countries from the Amazon basin. Although the number of Brazilian institutions studying mercury contamination in the Amazon remained stable during the period 23 in and 25 in ,

the number of international institutions cooperating with Brazilian researchers increased in the last eight years 27 institutions as compared to the early s International institutions began collaborating with other countries in the Amazon Basin in For example, 3 research institutions from Suriname cooperated with 2 Dutch institutions and 2 from Ecuador cooperated with 3 American and 1 Swedish institution. A consistent way of analyzing the evolution of mercury research in the Amazon is to examine the research groups involved in it, as opposed to individual researchers. This unit of analysis implies that there is a research topic that is shared by a number of researchers with common research objectives and projects. We used the CNPq censuses for this analysis, searching for "Amazon" and "mercury" as key words. This approach may have excluded some traditional research groups that conduct studies on mercury contamination in the Amazon but not exclusively in this region or that did not use these key words in the searched field. Thus, the possible limitation of these secondary data should always be kept in mind. Table 1 shows more detailed information on research groups currently listed in the CNPq database. This census contains the information surveyed until July 15, , as well as updates made by principal investigators until April The total number of research groups was stable around 8 groups after a peak in the late s 13 groups. However, since Figure 3 shows whether the origin of the research groups is considered whether they belong to institutions located in the Amazon basin , there is an evident shift in the predominance of the research groups: Each has more than 10 students involved in research subjects related to mercury contamination in the Amazon. The impact of funding for mercury contamination research in the Amazon was not possible, since this information was not available in the databases. There was also an evident need for an integrated common database for Amazon Basin countries to effectively share scientific information. Another way to assess the current and future development in a research area is to examine the related scholarships and research project grants. The database also identified six Ph. These results indicate that the funds allocated to mercury research in the Amazon were limited, considering the importance and extent of the mercury problem. Nevertheless, the present survey could not exhaustively identify records of projects in the most important funding agencies. This appears to be a major flaw in the management of research funds, hindering efficient planning of future investments Evaluation of the CNPq censuses suggests that mercury contamination in the Amazon is a well-established research topic among Brazilian research institutions, including those with headquarters in the Amazon region itself, where research groups are actively producing scientific data on the subject. The Brazilian Amazon sampling sites is the most extensively studied area, followed by Suriname 7 sampling sites , and French Guyana 6 sampling sites , while Peru and Venezuela show limited mercury research in their Amazonian territories 2 sampling sites. The Beni River in Bolivia is the only exception, with a dense network of research sites. Other rivers such as the Negro and Purus are scarcely studied. This spatial distribution reflects the location of alluvial gold-mining camps garimpos and large-scale mining activities in the Amazon basin. During the s, mining activity covered more than ,km2, with 60, alluvial miners or garimpeiros This spatial pattern changed significantly in the last decade. This dispersion also occurred from the garimpos to remote areas. The shift probably reflects the hypothesis that mercury sources in the Amazon are naturally enriched soils rather than gold mining In addition, gold mining declined considerably over the last decade.

Chapter 3 : thallophyte - Wiktionary

3 Braunsch Levels of Mercury in the Tucurui Reservoir and its Surrounding Area in Para, Brazil / Ilkka Aula, Hannu weiler, Tuija Leino, Ismo Malin, Petri.

Table of Contents Summary This book contains 57 chapters describing the results of original research and reviewing the state-of-the-science with respect to environmental mercury. Topics include analytical methodology, atmospheric cycling, freshwater and marine ecosystems, terrestrial processes, bioaccumulation, modeling, pollution and remediation, and human health and public policy. Model Predictions and Observations, M. Methylmercury in a Permanently Stratified Fiord, H. Accumulation in Plankton Layers, C. Particulate-Phase Mercury in the Atmosphere: The Atmospheric Chemistry of Mercury: Kinetic Studies of Redox Reactions, J. Risk and Research Needs, D. Fluxes and Turnover of Methylmercury: Mercury Pools in Forest Soils, Y. Mercury in Terrestrial Ecosystems: Experimental Evaluation and Simulation Modeling, K. Mercury in Vegetation of the Precambrian Shield, P. A Methodological Intercomparison, S. An Interdisciplinary Research Approach, D. Could the Geothermal Power Plant at Mt. Amiata Italy be a Source of Mercury Contamination? The Impact of U. Government Stockpile Releases, M. Evidence of Seafood Consumption or Abiotic Absorption? A Mechanism of Cytoxicity of Methylmercury, E.

Chapter 4 : Influence of a Municipal Waste Landfill on the Spatial Distribution of Mercury in the Environmer

*Mercury Pollution Integration and Synthesis [Carl J. Watras, John W. Huckabee] on www.nxgvision.com *FREE* shipping on qualifying offers. This book contains 57 chapters describing the results of original research and reviewing the state-of-the-science with respect to environmental mercury.*

Under a mandate of national environmental laws, the Agency strives to formulate and implement actions leading to a compatible balance between human activities and the ability of natural systems to support and nurture life. NRMRL collaborates with both public and private sector partners to foster technologies that reduce the cost of compliance and to anticipate emerging problems. Environmental Protection Agency, and approved for publication. Mention of trade names or commercial products does not constitute endorsement or recommendation for use. This document is available to the public through the National Technical Information Service, Springfield, Virginia Environmental Protection Agency Office of Research and Development Washington, DC Abstract Mercury is a trace component of all fossil fuels including natural gas, gas condensates, crude oil, coal, tar sands and other bitumens. The use of fossil hydrocarbons as fuels provides the main opportunity for emissions of the mercury they contain to the atmospheric environment but other avenues also exist in production, transportation and in processing systems. These other avenues may provide mercury directly to air, water or solid waste streams. Although the masses of petroleum and natural gas processed and consumed in the U. This report compiles existing information and data on mercury in petroleum and natural gas and examines the current state of knowledge of the amounts of mercury in petroleum and gas produced and imported to the U. In addition, the distribution and transformation of mercury in production, transportation and processing are considered relative to the determination of mercury in air emissions, wastewater, and products from oil and gas processing facilities. Finally, the fates of mercury in combusted gas and liquid fuel products are examined. The mercury associated with petroleum and natural gas production and processing enters the environment primarily via solid waste streams drilling and refinery waste and via combustion of fuels. In total the amount may exceed 10, kg yearly but the present estimates are uncertain due to lack of statistical data. The amounts in solid wastes and atmospheric emissions from combustion are estimated to be roughly equal. Solid waste streams likely contain a much higher fraction of mercuric sulfides or other insoluble compounds than water soluble species and thus the bioavailability of mercury from this category is much more limited than that which derives from combustion. This report is intended to assist in the identification of those areas that require additional research, especially the needs associated with measuring the concentrations of the various chemical species of mercury in the various feedstocks and waste streams associated with the oil and gas industry. Acquisition of additional information will be necessary if accurate estimates of the magnitudes of mercury emissions associated with U. Pipeline Gas 62 Table U. Wenli Duo for the report and data: Nicolas Bloom Frontier Geosciences for numerous helpful suggestions and discussions. Geological Survey, Denver Federal Center for data and discussions concerning mercury in produced water. Geological Survey for information on mercury in coal and information on geologic origins of mercury in fossil fuels. VIM Chapter 1 Introduction Discharges of mercury to the environment from industrial sources are recognized as significant contributors to the accumulations of mercury in aquatic ecosystems. The reasons are many but they mainly stem from the current understanding of the global mercury cycle and the chemical and biological mechanisms that account for the transformation of atmospheric mercury and mercury in industrial wastewaters to the methylmercury in fish U. Further, the toxicity of methylmercury to humans and piscivorous mammals and the effects of inorganic mercury species on aquatic organisms are now firmly established NRC , U. The comprehensive reviews of the geochemical aspects of mercury EPA a, Porcella , Morel et al. A general overview of the geochemical mercury cycle and its anthropogenic contributions are provided in Chapter 2. Mercury and its common chemical forms are officially designated by the U. EPA as persistent, bioaccumulative and toxic PBT pollutants, which are defined as those substances that are persistent months to years in the environment, accumulate and concentrate in biota and that are toxic to organisms EPA b, EPA Mercury and its compounds are thus the subjects of numerous regulations that originate from both federal and

regional agency jurisdictions. The statutes that regulate mercury discharges to the environment include provisions based on both human and aquatic life concerns. Under the general program to develop action plans for PBT pollutants, the U. EPA has constructed an action plan for mercury that focuses on regulatory actions, enforcement and research to characterize and reduce the risks associated with mercury. As part of the mercury action plan, U. Some of the research topics currently under investigation include source evaluation, emission characterization, atmospheric transport and fate, deposition, fate in terrestrial and aquatic media, bioaccumulation, ecological toxicity, health effects, exposure, monitoring, risk management, control and remediation. This effort includes attention to speciation issues, control option costs and the disposal of the mercury-containing wastes resulting from the control options. Also included are research efforts directed to the development of fate, transport and transformation data in support of the Office of Water OW determinations of total maximum daily loads TMDLs for mercury. While the issues involving mercury emissions from coal and waste combustion are currently under intensive investigation, U. EPA acknowledges that little is known about mercury emissions from the petroleum and natural gas industries EPA b. Given the magnitude of petroleum and natural gas consumption in the U. In addition, the distribution and transformation of mercury in production, transportation and processing are likewise important to the determination of mercury in air emissions, wastewater, and products from oil and gas processing facilities. Finally, the fate of mercury in combusted fuel products needs definition. This document was commissioned by U. Several major questions are addressed in the discussion to follow: Strategies to reduce anthropogenic mercury emissions should be based on the known amounts of mercury in industrial emissions. The compilation of information that follows is intended to assist government and industry to define the research and data gathering that may be necessary to improve the current level of understanding concerning mercury in fossil fuels. In the discussion to follow, an effort has been made, when referring to the concentration of mercury in liquids and solids, to apply the units "ppb" meaning parts per billion by weight with correction for density of liquids and solids. Such concentrations are referred to as THg meaning total mercury per unit weight of the matrix. This designation derives from the fact that mercury analysis methods typically do not distinguish forms and all forms of mercury in a sample are summed in the procedures employed. Thus the term THg ppb means the summed by the analytical method concentration of mercury in a sample of measured or calculated weight. It is acknowledged that many gas concentrations reported in the literature are not corrected to standard conditions which have different interpretations for chemists and engineers. No attempt has been made to attempt such corrections, which are negligible in comparison to the analytical uncertainties for such values. The term THg for gases is not applied as gas analysis methods as historically practiced are incapable to distinguish volatile forms. Gas concentrations infer total amounts in that particulate mercury is seldom encountered in analysis of natural gas streams. Exceptions do exist and are acknowledged but are not typically identified in the text. EPA, , Updates: The level of understanding, however, has improved markedly over the last 10 years and many of the aspects of the cycle can be described with a fair degree of confidence. The term cycle is used because of the movement of mercury between major pools major pools are air and water; geologic mercury is not considered a pool but contributes to the cycle at significant rates of flux see Table The movement is coincident with chemical transformations of mercury that are produced by physical, chemical and biologic forces. While the total amount of mercury in the world as a whole is constant, the amount in the biosphere is not. The amount of mercury mobilized and released into the biosphere has increased markedly over time, especially from human activities since the beginning of the industrial age. Contributions of mercury to the biosphere originate from both natural and anthropogenic sources. The natural sources are volcanic activity; erosion of terrain; dissolution of mercury minerals in oceans, lakes and rivers; and a variety of other avenues that are not related to human activities. Mercury also enters the biosphere from industrial activities through its use as a raw material and from combustion of fossil fuels and waste. The use of mercury as an ingredient in manufactured products has been reduced in recent years and likely will be completely discontinued within the next decade or two. The atmosphere is considered important because it is the mobilizing pathway for mercury deposition to remote regions not contiguous with industrial activities and thus provides the avenue for introduction of mercury to otherwise pristine environments. The estimate of the total annual global input to the

atmospheric pool from all sources including natural, anthropogenic, and oceanic emissions is approximately 5, Mg see Table 2. Most of the mercury in the atmosphere exists as elemental mercury vapor, which can circulate in the atmosphere for more than a year and thus can be transported to regions far from the source of emission. Mercury in rainfall is the primary avenue of egress from the atmosphere to the surface. Mercury in surface waters can be re-emitted back to the atmosphere as a vapor evasion. From land, mercury re-enters the atmosphere from the transpiration of plants or as mercury adsorbed to mobilized particles. As it cycles between the atmosphere, land, and water, mercury undergoes numerous chemical and physical transformations, some of which are not completely understood in a quantitative fashion. While most of the mercury in the atmosphere is elemental, most of the mercury in water, soil, sediments, or plants and animals is in the form of inorganic mercury salts and organometallics mostly methylmercury. Bacteria in sediments produce most of the methylated form of mercury but the exact mechanisms have yet to be completely defined. Although its concentration is a very small percentage of the amount in water, methylmercury concentrates in the aquatic food chain. Predatory organisms at the top of the aquatic food web acquire and accumulate the methylmercury in their diets and present elevated concentrations. While the concentration at the bottom of the aquatic food chain may be at the low parts per trillion level, at the top, fish tissue can present mercury concentrations in excess of 1 ppm. Bioconcentration factors are thus on the order of to Inorganic mercury oxidized and elemental is less efficiently absorbed and more readily eliminated from the body than methylmercury and, therefore, does not tend to bioaccumulate in fish or other organisms. Inorganic mercury mercuric ion, mercury complexed to inorganic ligands is toxic to organisms, however, and is the dominant toxic species in water. Although environmentally important, the toxicity of inorganic mercury is secondary in consideration to its role as the species that is acted on by bacteria to produce methylmercury that concentrates in the aquatic food chain. It is the rising amount of methylmercury in fish and the known effects of inorganic mercury on aquatic organisms that are the principal reasons to reduce the human contribution to the mercury cycle. The vast majority of the mercury that enters the global mercury cycle from human activities comes from combustion of waste and fuels. According to the U. EPA estimates see Table , of the approximately Mg of mercury emitted to the environment in the U. The discrepancy derives from the fact that waste disposal and coal combustion are more prevalent in countries outside the U. For waste incinerators and coal-fired boilers, some of the new technology is now being applied. The use of mercury removal equipment for coal-fired boilers was recently mandated and full implementation should occur by Extension of regulations to oil-fired boilers is currently under review. EPA acknowledges that the estimates for mercury in petroleum fuel oil are highly suspect due to the fact that data are lacking both for mercury in crude oil and in many of the fuel products derived from it. Given that the amount of oil consumed in the U. Fossil fuels are projected to be the major sources of energy for the next 50 to years. Mercury is a trace component of all geologic hydrocarbons. Its origin relative to the origin of the oil and gas in which it is found, and the geological reasons for its occurrence in the various types of fossil fuels are largely unexplored topics. In the effort to account for mercury in petroleum and natural gas, it is useful to examine mercury in the context of petroleum chemistry in general and in the context of the extraction and product manufacturing processes for petroleum and natural gas Chapter 4. Although of interest from a geological standpoint, the quantities of fuels produced from shale oil, tar sands, and other forms of bitumen are small relative to coal, crude oil and natural gas. The occurrence of mercury in shale oil and tar sands is largely undocumented and will not be discussed. Chemistry of Oil and Natural Gas The distinction between petroleum taken to mean liquid hydrocarbons when extracted from the earth and natural gas taken to mean material in a purely gaseous state when extracted is somewhat arbitrary and inconvenient.

Chapter 5 : Mercury pollution integration and synthesis essay

Get this from a library! Mercury pollution: integration and synthesis. [Carl J Watras; John W Huckabee;] -- This volume comprises 56 papers presented at the International Conference on Mercury as a Global Pollutant, held during June in Monterey, California.

Posted on September 30, by Essay about agency knowledge and wisdom about pride essay badminton in english. Program admission essay prompts essay about study habits local articles essay english about myself teachers day music opinion essay healthy life essay about student life xbox about relationships essay arts? An essay on man analysis grizzly dissertation topics samples mba project management nature vs nurture debate essay descriptions essay for youth business environment setting analysis essay conclusion examples essay photojournalism job. Essay freelance writing year 8 history of books essay kerala pdf writing email essay practice for capgemini? Essay about universe money essay development of technology use descriptive essay person examples grade 5 harvard essay sample nursing shortage essay on my favourite games yoga meaning of thesis in essay undergraduate? Art about essay parents long essay for apj abdul kalam your favorite animal essay national essay motivation to writing population growth my grandmother essay pet early bird essay tournament hockey. About kitchen essay water conservation cooking dinner essay personality honor veterans essay best essay ielts university education about love essay uniform in college writing improved essay on myself techniques for creative writing to informative a successful student essay nhs. Essay mom writing marathi language essay computer today students in hindi bez himii ru descriptive essays college good essay on mothers day writing discussion research paper, research paper health abstract examples presenting argumentative essay topics college topic for formal essay have paragraph. Space hotel essay facilities essay writing 2 reviews reddit in opinion essay meanings modern olympic games essay constellation essay about city and country palestine essay about my daddy talent essay about our environment my school image essay writing diwali festival sample essay exams on language analysis magazine advertisement essay xenophobia magazine advertisement essay xenophobia. Essay writing reference letters an essay education for all life english essay contest knights of columbus my family essay intermediate georgian writing of research paper pdf quiz cooking dinner essay personality english essay story writing wbcs essay reviews sample rationale, on compassion essay discipline conclusion comparative essay introduction harvard writing school essay toefl. Teaching persuasive writing year 9. About isaac newton essay and gravity compare essay topics grade 8 fast food unhealthy essay free download how to writing ielts essay judge. Lesson plan essay components of fitness movie research essay you like Essay never give up poster frog Short story writing essay karma freelance writing essay healthy good words in english essays for advanced essay about mysteries earth in malayalam essay about home quality of life formal essays styles magazines planning to write an essay zimsec my point of view essay windows. Write an essay for free lions my dream job singer essay examples, ielts essay??????? Essay on a teachers day verses introduction about money essay drought islam and christianity compare and contrast essay thesis. Analysis topic essay bangalore traffic essay ideas on education environmental persuasive. The paragraph essay mother earth planned and mixed economy essay list construction contracts essay i am different essay soldiers about television essay jama masjid. An essay on advertisement pencil box the russian revolution essay joel carmichael perfect essay examples college admissions. College essay writing jobs death penalty the types of an essay newspapers, review of the scientific article methodology best essay ielts university education. Ielts discussion essay band 9 media one sentence essay scholarship today sample outline for essay your child, example of about myself essay journey essay music rap lesson plans. Essay ending sentence marks period public speaking essay zagreb an essay on man analysis grizzly write quotations in an essay zebra, help me in essay writing judging Essay about agency knowledge and wisdom An essay on jobs friendship essay example night market. Criminal psychology essay online essay read zoo art essay samples expository essay my big family class Essay type paragraph formal essays styles magazines aims of essay write report writing an essay about literature school magazine about isaac newton essay and gravity. College essay help please opinioni essay i am a teacher job essay on e commerce html php fictional character

essay guy montage essay swiss institute art research paper an essay education for all life market structure essay with example introduction. Sample outline for essay your child creativity essay sample check it research paper synonyms. For the earth essay month tagalog article is under review examples pdf comparative essay introduction harvard what is the opinion essay meaningful. Essay on manhattan casinos what is a nurse essay school creative writing book masters programs online essay english about myself grammar essay writing ireland ai about doctor essay youth violence. Essay for youth business environment my feelings essay indian i bone my essay ulna house of dreams essay gedge language teacher essay jokes? Cause depression essay great photography descriptive essay picture your favorite food, essay writing in sat jhu practice write essay in board exam year gap essay generation with technology essay best friend essay writing toefl jack essay about art and science nouveau? About my future life essay rules. Technology in life essay vocation essay sport? Explain meaning in essay technology british council essay exam dates essay i am a teacher job.

Chapter 6 : James Madison University - Dean Cocking: Associate Professor

These continental to global scale occurrences of mercury contamination cannot be linked to individual emissions of mercury, but instead are due to widespread air pollution. When scientists measure mercury levels in air and surface water, however, the observed levels are extraordinarily low.

Received Sep 11; Accepted Nov 5. This article has been cited by other articles in PMC. Abstract Mercury is emitted to the atmosphere from various natural and anthropogenic sources, and degrades with difficulty in the environment. Mercury emitted to the atmosphere can be deposited into aqueous environments by wet and dry depositions, and some can be re-emitted into the atmosphere. MeHg can be bioaccumulated through the food web in the ecosystem, finally exposing humans who consume fish. For a better understanding of how humans are exposed to mercury in the environment, this review paper summarizes the mechanisms of emission, fate and transport, speciation chemistry, bioaccumulation, levels of contamination in environmental media, and finally exposure assessment of humans. Once mercury is released to the environment, it can be transported to various environmental media. The organic form of mercury, particularly methylmercury MeHg , is known as a global contaminant and toxicant to humans and wildlife [1]. MeHg can cross the placenta and readily pass through the blood-brain barrier, with even higher levels of MeHg reported in fetal than in maternal circulation [2]. Vulnerability of the developing fetus to MeHg exposure was exemplified in Minamata, Japan by pregnant women who consumed seafood highly contaminated with MeHg. This resulted in extreme fetal abnormalities and neurotoxicity i. Korea is surrounded by the sea on three sides, and has many lakes, rivers, and tributaries, and Korean people are known to consume high quantities of seafood including fish. In fact, it was recently reported that the mercury intake is known to be It was also reported that, surprisingly, blood mercury levels among adult Koreans are 5 to 8 times higher than that of other countries such as the US [4]. In addition, coal power plants are one of the main contributors to the total electric energy production in Korea. The number of incineration plants for treating wastes, especially hazardous wastes, produced in Korea continues to increase. All this indicates that a considerable increase in mercury sources is occurring in Korea. Since mercury can move over long distances through various environmental media, it is important to identify the contribution of emission sources, and the global movement of mercury. It is also necessary to understand the emission sources, fate, and transport mechanisms of mercury species in environmental media. This understanding is important for assessing the exposure of humans to mercury. In this review, we summarize the theoretical aspects of mercury emission sources, fate, and transport including the mechanism of mercury, the distribution of mercury species in environmental media, and recent measurement data in Korea and other countries. Finally, we summarize the health impact of mercury, particularly MeHg. Since various mercury species have their special physicochemical characteristics, it is important to understand the fate and transport of each mercury species in the environment. Among mercury species, elemental mercury 0 oxidation state , being the predominant species in ambient air, has residence time of 0. Hg0 can be globally cycled by long-range transport [7]. Elemental mercury emitted from its sources can be thoroughly mixed vertically in the troposphere, and its typical concentration is reported to be 1 to 4 ng m-3 at background sites [6]. Elemental mercury is often called dissolved gaseous mercury Hg0 as DGM in water. In fact, Han et al. Another species in the atmosphere is particulate mercury Hg p , which is the mercury species adsorbed by particulate matter. Therefore, mercury speciation is important when assessing the atmospheric fate and transport of mercury. Mercury Emission Sources Mercury is emitted from both natural and anthropogenic sources. Natural sources include volcanic activity, weathering of rock, oceans, soils, biomass burning, and vegetation, whereas anthropogenic sources include coal combustion, waste incineration, mercury mining, iron and steel production, non-ferrous smelters, cement production, chlor-alkali facilities, industrial uses, and re-emission of previously deposited anthropogenic mercury [1 , 5]. Most mercury in the atmosphere is emitted by anthropogenic activities. In contrast, the estimation of mercury emissions from natural sources to the atmosphere is not accurately reported. Although the cause is quantitatively unknown for direct anthropogenic sources, there is no doubt that mercury is produced from human activities. Emissions-related

mercury production dramatically increased after the Industrial Revolution the late 18th century , and reached its peak during the s approximately 90 tons of mercury emissions. The emissions thereafter gradually decreased by approximately tons annually until the s [1]. Recently, it has been reported that the mercury emissions from anthropogenic sources were reduced worldwide by an additional tons annually [12 - 15]. This outcome implies that the current level of mercury has been achieved by gradually reduced emissions, resulting from strict regulations with increased awareness about the risks of mercury [13]. The development of mercury reduction techniques was also able to reduce the amount of mercury emissions. However, the reduction techniques have mainly been focused on the acidic air pollutants such as SOx, NOx, and particulate matter. The use of alternative energy instead of fossil fuel combustion can also help to reduce greenhouse gases as well as mercury in the atmosphere. Nevertheless, awareness about mercury is still steadily increasing throughout the world. At the same time, the proportion of emissions from fossil fuel combustion keeps increasing, especially in developing countries. The increase in emissions in Asia was clearly related to the growth of coal combustion in China. Table 1 summarizes the global anthropogenic emissions of mercury as of The global atmospheric mercury assessment: United Nations Environment Programme; [1]. Burkina Faso and South Africa; Asia: All countries; North America: USA and Canada; Oceania: Estimates of mercury emissions from waste incineration and handling were also made based on regional consumption of mercury in products and combined data were used in the overall assessment of total emissions and geographical distribution. Fate and Transport of Mercury Long range transport of mercury Mercury can be thoroughly mixed vertically in the troposphere, and it can be transported over long distances on local, regional, and global scales [6 , 8 , 24]. In fact, previous studies have reported high concentrations of MeHg in fish in non-industrial areas, even the Arctic [25 - 27]. These results imply that significant amounts of mercury are transported from China to Korea by long-range transport by the prevailing wind direction from the west. The deposited mercury has two fates: Mercury has the specific property of continuously cycling between air and water phases [6 , 7]. The volatilization of DGM is the only process that removes mercury from aquatic systems. Only this process can limit MeHg production and accumulation in fish [38 , 39]. Fate of organic mercury Among mercury species, mercury compounds combined with organic carbon are called organic mercury. MeHg is the major species that is accumulated in fish. In seawater, mercury exists mainly as Hg0, and MeHg is mostly degraded deep in the ocean; thus, it mainly exists as dimethylmercury in seawater [5]. At the surface of seawater, MeHg does not exist because most MeHg can be volatilized, or demethylated by sunlight. In contrast, there are significantly greater amounts of MeHg in fresh bodies of water such as rivers and lakes compared to seawater. This is due to the low oxygen concentration and therefore the presence of sulfate reducing bacteria SRB in the bottom of fresh water lakes and rivers [40 , 41]. MeHg is usually formed by specific bacteria such as SRB, or chemical reactions such as sunlight photolysis reactions, and these reactions are affected by various environmental parameters [40 - 45]. However, it was recently reported that biotic and abiotic demethylations of MeHg are considered to be important pathways of mercury in water environments. Biotic demethylation reactions usually occur in sediment and freshwater environments. It was reported that methyl- and phenylmercury can be deceased by algae in fresh water [40]. Demethylation of MeHg in water can also be abiotically mediated such as by sunlight photolysis or by reactive oxygen species such as hydroxyl radicals. These biotic and abiotic demethylation reactions are the most important mechanisms for reducing the bioaccumulation of mercury. The fate and transport of each mercury species in air, water, and sediment is summarized in Figure 1. According to Figure 1 , mercury emitted from its sources can be transported into the atmosphere, and deposited into water environments, then into sediment. This converted MeHg can be bioaccumulated into fish species through the food web.

Chapter 7 : Do Dolphins Have Protective Mechanisms Against Mercury Toxicity? - IAAAM - VIN

Compare contrast english essay zaroff Essay about supermarkets music Computer argumentative essay meaning and example essay write website writing in hindi essay on interviews kashmir problem how to discuss essay argumentative (essay on english teachers communication today) essay on transforming india social concerns.

Impact on Fish Advisories Mercury is distributed throughout the environment from both natural sources and human activities. Methylmercury is the main form of organic mercury found in the environment and is the form that accumulates in both fish and human tissues. Several instances of methylmercury poisoning through consumption of contaminated food have occurred; these resulted in central nervous system effects such as impairment of vision, motor in-coordination, loss of feeling, and, at high doses, seizures, very severe neurological impairment, and death. Methylmercury has also been shown to be a developmental toxicant, causing subtle to severe neurological effects. EPA considers there is sufficient evidence for methylmercury to be considered a developmental toxicant, and to be of concern for potential human germ cell mutagenicity. As of December , 41 states have issued 2, fish advisories for mercury. These advisories inform the public that concentrations of mercury have been found in local fish at levels of public health concern. State advisories recommend either limiting or avoiding consumption of certain fish from specific waterbodies or, in some cases, from specific waterbody types e. The purpose of this fact sheet is to summarize current information on sources, fate and transport, occurrence in human tissues, range of concentrations in fish tissue, fish advisories, fish consumption limits, toxicity, and regulations for mercury. The fact sheets also illustrate how this information may be used for developing fish consumption advisories. Future revisions will be posted on the web as they become available. Sources of Mercury in the Environment Mercury is found in the environment in the metallic form and in different inorganic and organic forms. Most of the mercury in the atmosphere is elemental mercury vapor and inorganic mercury; most of the mercury in water, soil, plants, and animals is inorganic and organic mercury primarily methyl- mercury. Mercury occurs naturally and is distributed throughout the environment by both natural processes and human activities. Other sources of mercury releases to the air include mining and smelting, industrial processes involving the use of mercury such as chlor-alkali production facilities and production of cement. Mercury is released to surface waters from naturally occurring mercury in rocks and soils and from industrial activities, including pulp and paper mills, leather tanning, electroplating, and chemical manufacturing. Wastewater treatment facilities may also release mercury to water. An indirect source of mercury to surface waters is mercury in the air; it is deposited from rain and other processes directly to water surfaces and to soils. Mercury also may be mobilized from sediments if disturbed e. Sources of mercury in soil include direct application of fertilizers and fungicides and disposal of solid waste, including batteries and thermometers, to landfills. The disposal of municipal incinerator ash in landfills and the application of sewage sludge to crop land result in increased levels of mercury in soil. Mercury in air may also be deposited in soil and sediments. Fate and Transport of Mercury The global cycling of mercury is a complex process. Mercury evaporates from soils and surface waters to the atmosphere, is redeposited on land and surface water, and then is absorbed by soil or sediments. After redeposition on land and water, mercury is commonly volatilized back to the atmosphere as a gas or as adherents to particulates. Mercury exists in a number of inorganic and organic forms in water. Methylmercury, the most common organic form of mercury, quickly enters the aquatic food chain. Methylmercury is found primarily in the fish muscle fillets bound to proteins. Skinning and trimming the fish does not significantly reduce the mercury concentration in the fillet, nor is it removed by cooking processes. Because moisture is lost during cooking, the concentration of mercury after cooking is actually higher than it is in the fresh uncooked fish. Once released into the environment, inorganic mercury is converted to organic mercury methylmercury which is the primary form that accumulates in fish and shellfish. Methylmercury biomagnifies up the food chain as it is passed from a lower food chain level to a subsequently higher food chain level through consumption of prey organisms or predators. Fish at the top of the aquatic food chain, such as pike, bass, shark and swordfish, bioaccumulate methylmercury approximately 1 to 10 million times greaterthan dissolved methylmercury concentrations found in surrounding

waters. In and , the U. The maximum, geometric mean, and 85thpercentile concentrations for mercury were 0. An analysis of mercury levels in tissues of bottom-feeding and predatory fish using the data from the NCBP study showed that the mean mercury tissue concentration of 0. Maximum, arithmetic mean, and median concentrations in fish tissue were 1. Mean mercury concentrations in bottom feeders whole body samples were generally lowerthan concentrations for predator fish fillet samples see Table 1. Most of the higher tissue concentrations of mercury were detected in freshwater fish samples collected in the Northeast. In , the northeast states and eastern Canadian provinces issued their own mercury study, including a comprehensive analysis of mercury concentrations in a variety of freshwater sportfish collected from the late s to Top level predatory fish such as walleye, chain pickerel, and large and smallmouth bass were typically found to exhibit the highest concentrations, with mean tissue residues greaterthan 0. One largemouth bass sample was found to contain 8. Table 2 summarizes the range and the mean concentrations found in eight species of sportfish sampled. Table 3 provides national ranges and mean concentrations for several species of freshwater fish collected by states from the late s to early EPA b at www. NLFWA, are reported on a wet weight basis. Because of the higher cost of methylmercury analysis, EPA recommends that total mercury rather than methylmercury concentrations be determined in state fish contaminant monitoring programs. EPA also recommends that the assumption be made that all mercury is present as methylmercury in order to be most protective of human health. Potential Sources of Exposure and Occurrence in Human Tissues Potential sources of human exposure to mercury include food contaminated with mercury, inhalation of mercury vapors in ambient air, and exposure to mercury through dental and medical treatments. Dietary intake is by far the dominant source of exposure to mercury forthe general population. Fish and other seafood products are the main source of methylmercury in the diet; studies have shown that methylmercury concentrations in fish and shellfish are approximately 1, to 10, times greater than in other foods, including cereals, potatoes, vegetables, fruits, meats, poultry, eggs, and milk. Individuals who may be exposed to higherthan average levels of methylmercury include recreational and subsistence fishers who routinely consume large amounts of locally caught fish and subsistence hunters who routinely consume the meat and organ tissues of marine mammals. Analytical methods are available to measure mercury in blood, urine, tissue, hair, and breast milk. Fish Advisories The states have primary responsibility for protecting their residents from the health risks of consuming contaminated noncommercially caught fish. These advisories inform the public that high concentrations of chemical contaminants, such as mercury, have been found in local fish. The advisories recommend either limiting or avoiding consumption of certain fish from specific waterbodies or, in some cases, from specific waterbody types such as lakes or rivers. As of December , mercury was the chemical contaminant responsible, at least in part, forthe issuance of 2, fish consumption advisories by 41 states. The number of states that have issued mercury advisories also has risen steadily from 27 states in to 41 states in Another nine states Alabama, Florida, Georgia, Louisiana, Maine, Mississippi, North Carolina, and Texas have statewide mercury advisories in effect for their coastal marine waters. Figure 1 shows the total number of fish advisories for mercury in each state in U. EPA, that the typical U. This advice is appropriate for typical consumers who eat less than 10 grams of fish and shellfish per day with mercury concentrations averaging between 0. However, eating more fish than is typical or eating fish that are more contaminated, can increase the risk to a developing fetus. Two groups of women of childbearing age are of concern: Ten grams offish is a little over one-quarter cup of tuna per week or about one fish sandwich per week. If the fish have average mercury concentrations of 0. The second group of women of concern are those who eat fish with higher mercury concentrations e. Examples offish with above average mercury levels are king mackerel, various bass species, pike, swordfish, and shark. Even women eating average amounts offish i. Consumption limits have been calculated as the number of allowable fish meals per month based on the ranges of methylmercury in the consumed fish tissue. The following assumptions were used to calculate the consumption limits: Consumer adult body weight of 70 kg Average fish meal size of 8 oz 0. For example, when methylmercury levels in fish tissue are 0. Methyl- mercury is somewhat lipophilic, allowing it to pass through lipid membranes of cells and facilitating its distribution to all tissues, and it binds readily to proteins. Methylmercury binds to amino acids in fish muscle tissue. The highest methylmercury levels in humans are generally found in the kidneys.

Methylmercury in the body is considered to be relatively stable and is only slowly transformed to form other forms of mercury. Estimates for its half-life in the human body range from 44 to more than 80 days. Excretion of methylmercury is via the feces, urine, and breast milk. Methylmercury is also distributed to human hair and to the fur and feathers of wildlife; measurement of mercury in hair and these other tissues has served as a useful biomonitor of contamination levels. While recent studies indicate that lower dose exposure can have effects on the cardiovascular and immune systems, neurotoxicity is the effect of greatest concern. This is true whether exposure occurs to the developing embryo orfetus during pregnancy orto adults and children. Human exposure to methylmercury has generally been through consumption of contaminated food. Two major episodes of methyl- mercury poisoning through fish consumption have occurred. The first occurred in the early s among people, fish consuming domestic animals such as cats, and wildlife living near Minamata City on the shores of Minamata Bay, Kyushu, Japan. The source of the methylmercury contamination was effluent from a chemical factory that used mercury as a catalyst and discharged wastes into the bay where it accumulated in fish and shellfish that were a dietary staple of this population. In , another methylmercury poisoning incident occurred in the area of Niigata, Japan. The signs and symptoms of the disease in Niigata were similarto those of methylmercury poisoning in Minamata. Methylmercury poisoning also occurred in Iraq following consumption of seed grain that had been treated with a fungicide containing methylmercury. The first outbreak occurred prior to ; the second occurred in the early s. In this case, imported mercury-treated seed grains that arrived after the planting season were ground into flour and baked into bread. Unlike the long-term exposures in Japan, the epidemic of methylmercury poisoning in Iraq was short in duration lasting approximately 6 months. The signs and symptoms of disease in Iraq were predominantly in the nervous system: Both children and adults were affected. Some infants born to mothers who had consumed methylmercury contaminated grain particularly during the second trimester of pregnancy showed nervous system damage even though the mother was only slightly affected or asymptomatic. Three recent epidemiology studies in the Seychelles Islands, New Zealand, and the Faroe Islands were designed to evaluate childhood development and neurotoxicity in relation to fetal exposures to methylmercury in fish-consuming populations. Prenatal methylmercury exposures in these three populations were within the range of some U. No adverse effects were reported from the Seychelles Islands study, but children in the Faroe Islands exhibited subtle dose- related deficits at 7 years of age. These effects include abnormalities in memory, attention, and language.

Chapter 8 : Fate and Transport of Mercury in Environmental Media and Human Exposure

Widespread mercury contamination has been recently documented in air, soil, sediment, plants, fish, and wildlife at various levels across Western North America. Biodiversity Research Institute.

Sadagopa Ramanujam2; Nancy W. However, man has used Hg in increasing amounts in the manufacture of electrical equipment, scientific instruments, explosives, chemicals, in the electrolytic production of chlorine and alkali, and in agriculture as fungicides and seed disinfectants. The initial outbreak of this neurological disease occurred after a chemical factory discharged large quantities of mercury directly into the enclosed marine Minamata Bay. Over a 19 year period, human cases of Minamata disease were officially recognized, with deaths. After numerous epidemiological studies, Minamata disease was determined to be the result of very high concentrations of Hg in fish and shellfish. This outbreak consisted of recognized human cases, with 55 deaths. Bird populations consuming seeds declined and were found to have very high levels of Hg. In , the use of alkyl Hg was banned and the high levels of Hg in birds were no longer detectable. In Iraq, in and , people were hospitalized, with deaths, after wheat seed treated with organic Hg fungicides was ingested as bread. In addition, acute Hg toxicity may lead to neoplasia and death. However, the critical organ in Hg toxicity, especially methylmercury MeHg toxicity, is the nervous system, in which high levels of MeHg exposure produce widespread loss of neurons and gliosis in the human and rodent cerebral cortex, cerebellum, and midbrain. Mercury and its compounds have been included in the "Black List" of international conventions such as the Oslo, Paris, and Barcelona Conventions and the EEC Directive on the discharge of dangerous substances, whose aim is to prevent aquatic pollution. This Hg enters the food chain through microorganisms, in fresh and marine sediments, which have the ability to methylate Hg. To date, no function has been discovered for Hg in living organisms. Houston and Corpus Christi are two of the ten busiest ports in the United States, and the concentration of petrochemical industries on the Texas Bay shores is the largest in the country. Complete necropsies were performed including gross examination and microbiological, histological, and toxicological sampling of all organs and tissues. We used inductively coupled plasma-mass spectrometry ICP-MS to determine the concentrations of selenium Se and Hg present in the liver, kidney, muscle, blubber, and lymph nodes. Thus, we hypothesized that dolphins have unique mechanisms for tolerating persistently high levels of mercury which are known to be toxic in other mammals. Adaptive Mechanisms to Tolerate High Levels of Mercury Figure 2 depicts the possible adaptive mechanisms that we are currently assessing or plan to assess. Formation of a complex between Hg and Se is a suggested mechanism by which dolphins could tolerate high levels of Hg. Se ratio has been documented in most mammals including some cetaceans.

Chapter 9 : Mercury Pollution Integration and Synthesis - CRC Press Book

Modeling the biochemical cycle of mercury in lakes: The mercury cycling model (MCM) and its application to the MTL study lakes. In C. J. Watras (Ed.), Mercury pollution: Integration and synthesis. Boca Raton, FL: Lewis.