Chapter 4: Risk management

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4.1. Problem-solving exercise: emergency response to a PCB fire
Prepared by Evert Nieboer

Time: One 2-3-hour classroom sessions (allow time for independent study, if desired)

Objectives:
At the end of the exercise, students will be able to:
1. Review the principles of risk management in the context of emergency preparedness, emergency response and the safe use and disposal of hazardous products.
2. Recognize the need for reliable toxicological data, empirical (analytical) data and interdisciplinary teamwork in emergency response and its follow-up.
3. Organize and implement adequate community preparedness and preventive measures for chemical spills or fires in industrial accidents that pose a health risk to the public.

Procedures:
1. Introduce the exercise and review its objectives. Divide participants into small groups (4-6 persons). Instruct participants to identify a chairperson and a recorder.
2. The problem scenario is divided into three sequential parts:
   — Part I consists of a vignette;
   — Part II provides factual information to help students to understand the problem better;
   — Part III provides the outcome. The decision to proceed to the next stage should be made jointly by students and instructor. You can schedule plenary sessions to review student responses to the material at any stage in the process and before distributing new information.
3. Distribute the exercise and review the participants' tasks.
4. Reconvene the groups and invite a response from one group to the first question. Ask whether other groups have different responses. Summarize and, if necessary, expand on the participants' responses and proceed to Question 2. Allow a different group to initiate the discussion and continue in this way until all questions have been answered. Possible answers to the

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questions are provided below. These answers are not all-inclusive. Instructors are encouraged to develop alternative responses and intervention strategies that are appropriate to the local situation.

5. Summarize the results, emphasizing key messages. The decision to proceed to Part II should be made jointly by students and instructor.

**Materials:**

Problem-solving exercise in three parts (Annex 7), flip chart, coloured markers.

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**Case scenario, Part I**

Your group has been appointed to coordinate the emergency and follow-up responses to a fire that is burning out of control at a PCB warehouse in a community north-east of the city of Montreal, Canada. The cloud of smoke and soot can be seen a long distance away and is moving in a north-westerly direction. In its path are three towns (total population of approximately 4000), interspersed with farmland (livestock, dairy and crop farms). Fire-fighters are at the scene.

**Question 1. What are the PCBs and what hazards do they pose to human health? What information retrieval sources are you going to consult? Remember, immediate answers are required.**

Consultation of a material safety data sheet (MSDS) provided by the Fire Marshall's office indicates that polychlorinated biphenyls (PCBs) are persistent organic pollutants (POPs) that are toxic to the environment and humans; they bioaccumulate in the food chain, occurring in fish and wildlife and are secreted into milk.

Most of what one needs to know about PCBs and related compounds is provided in Part II of the problem scenario. In many countries, PCBs and dioxins have become renowned environmental toxicants, and thus they are among the most feared chemicals. Because there is a gap between their perceived adverse effects and what is documented with certainty, critical reading of the literature is required. For example, using epidemiological guidelines for establishing causal relationships, Swain (1991) arrived at the following conclusions for intrauterine exposure through the consumption of contaminated fish:

(i) consumption of contaminated fish correlates with serum PCB levels;
(ii) evidence for intrauterine exposure to PCBs is consistent between studies;
(iii) evidence for alterations in maternal health status is weak;
(iv) while the Yusho and Yu-Cheng acute exposure incidents demonstrated decreases in size at birth and gestational age, the evidence for the low-dose chronic exposure studies is weak;
(v) effects on behavioural functions and responses in neonates and subtle behavioural and cognitive deficits in infants (6-12 months) appear established with a reasonable degree of certainty;
(vi) effects on cognitive function in early childhood (at 4 years of age) must be regarded as uncorroborated since the evidence originates from a single study.

Recently, Kimbrough (1995) has concluded for PCBs that the "available evidence for cancer and for reproductive effects is inconclusive". MSDSs constitute quick sources of toxicological and first aid information, but additional knowledge is required to initiate an emergency response. Emergency response personnel such as the Fire Marshall or Medical Officer of Health will have manuals or perhaps on-line information on chemical-specific risk and emergency response. Because of the scale of the problem, medical and toxicological experts from government agencies or universities may need to be sought and brought in as quickly as possible.

**Question 2. What immediate actions should be taken and who should be involved?**

An interdisciplinary and intersectoral emergency team needs to be assembled and a command post set up to work with the fire department, community health officials and local authorities to:

(i) determine the extent of the affected area;
(ii) determine weather conditions (wind direction and velocity; whether rain is anticipated);
(iii) assess the need for evacuation;
(iv) determine the amount of the PCBs consumed in the fire;
(v) determine the extent of exposure to PCBs, PCDDs and PCDFs by collecting samples for immediate analysis (air, water, surface dust inside and outside homes, vegetables, grass, livestock, cows’ milk, etc.);
(vi) implement an analytical quality assurance programme;
(vii) establish medical check-ups and other services;
(viii) carry out health risk assessment;
(ix) issue health advisories;
(x) establish risk communication;
(xi) ensure follow-up (decontamination and restoration; medical);
(xii) decide on the need for an official inquiry.
Case scenario, Part II

Ministry of Environment records show that 500 drums (~100,000 litres) of a dielectric fluid called "askarel", containing up to 70% PCBs, were stored in the warehouse.

PCBs have the formula C_{12}H_{10-n}Cl_n with n=1 to 10; they constitute a family of 209 compounds called congeners that are characterized by different halogenation and phenyl-ring substitution patterns. PCBs mixed with mineral oil are used as insulating fluids, coolants and lubricants in high temperature electrical equipment. Pyrosynthetic products of PCBs include polychlorinated dibenzofurans (PCDFs) and dibenzodioxins (PCDDs). The Canadian Environmental Contaminants Act limits the use of PCBs, although their continued presence in equipment built before 1 July 1980 is permitted. These regulations also limit the concentration of PCBs in equipment offered for sale or in material released into the environment to 50 parts per million by weight. Further, the release from any one piece of equipment is limited to 1gm per day. Approved methods for the destruction of PCBs are slowly becoming available.

Acute exposure to PCBs (as well as PCDFs and PCDDs) results in a clinical syndrome of "PCB poisoning" characterized by skin abnormalities (chloracne) and oculodermatological symptoms, mucosal surface irritation, abnormal liver function, elevated serum triglycerides and peripheral neuropathy. Non-specific symptoms include excessive fatigue, anorexia and weight loss. Long-term concerns, based on the Yusho (Japan) and Yu-Cheng (Taiwan) epidemics caused by accidental ingestion of rice oil contaminated with PCBs and minor amounts of PCDFs, are reproductive and non-permanent developmental effects in infants, and cancer. These concerns are accentuated by the aftermath of the release of PCDDs in a 1976 explosion in a chemical plant near Seveso, Italy. The International Agency of Research on Cancer (IARC) lists PCBs as Group 2A carcinogens (limited human and sufficient animal evidence); TCDD (2,3,7,8-tetrachlorodibenzo-para-dioxin) is assigned to Group 2B (inadequate human evidence but sufficient animal evidence). PCBs, PCDFs and PCDDs are believed to act as environmental estrogens or antiestrogens (see Exercise 2.4). They are considered to act as endocrine-disrupting contaminants in wildlife species and humans. The quantitative analysis of air, water and biological samples for these compounds requires considerable expertise and sophistication.

Question 3. Should the inhabitants of the three towns be evacuated? Who should make that decision?

Debate whether the toxicological concern and the potential magnitude of the PCB fire are sufficient reasons to evacuate persons living in the immediate pollution zone. The senior health official (e.g. the local Medical Officer of Health) and the Fire Marshall might be in the best position to make this decision. This discussion should take place before Part III of the scenario is handed out.

Question 4. What measures should be implemented for environmental monitoring, biological monitoring and health effects monitoring? Who ought to be involved in such programmes? What group of individuals is likely to be at highest risk?

This has already been partially answered in the answer to Question 2. See also Part III of the problem scenario.
Case scenario, Part III

Residents of the nearby towns were evacuated immediately by the authorities and emergency accommodation was arranged. Specific instructions for evacuees and people living in neighbouring districts were made available through the Ministries of Agriculture (concerning consumption of local vegetables, milk, meat, etc.), Health, and Environment and via 24-hour telephone hotlines. It was strongly recommended that breast-feeding be stopped. Fire-fighters and others who were heavily exposed were given immediate medical attention, monitoring and psychological support (debriefing, counselling if required). A detailed questionnaire issued to 5000 persons was used to assess the probability of exposure. An ad hoc panel was convened, including local, national and international experts. Three task-groups were formed. Task-group I initiated and supervised the collection and analysis of environmental samples (air, dust on interior and exterior surfaces, soil, water, vegetation), as well as biological samples (e.g. serum levels of PCBs in most heavily exposed groups and in maternal milk). The environmental data was employed by task-group II in risk assessment calculations and in determining when to allow people to return home. Task-group III determined what short-term and long-term medical and psychosocial actions were needed for the exposed population and emergency respondents.

About 8% of the PCBs stored in the warehouse were actually burned. Harmonization and quality control of the analytical laboratories identified some aberrant methodologies which were corrected. In most of the environmental samples, PCBs were below the threshold of detection. Because some dust droplets were found that were contaminated with PCBs, dioxins and furans, all the homes and cars in the affected area were washed (special instructions were given). Although local vegetables were only minutely contaminated, an embargo was placed on this year’s crop of produce. No traces of contaminants were found in blood, milk and faeces of animals tested. Milk from the area was allowed to go for pasteurization two weeks after the exposure. Government compensation for losses was made available. The determination of PCDDs, PCDFs and planar PCB congeners (the most toxic group) in breast milk during the first three days showed no elevation. Women were reassured and breast-feeding was resumed. Breast milk analyses during the subsequent weeks and months confirmed the initial conclusion of negligible exposure. Although 5000 people in all were medically examined and tested, only some of the fire-fighters, police and emergency respondents who participated in containment and clean-up had higher-than-average liver enzyme levels in their sera. These latter individuals also showed some symptoms of the PCB poisoning syndrome, had evidence of mild elevation of serum PCBs, and will be subjected to long-term follow-up. These findings indicated improper protection when on emergency duty. Psychosocial impact assessments will also be pursued for at least six months. Quantitative risk calculations confirmed that, other than the "heavily exposed" groups, the general public were not at risk and would not be resettled provided the required precautionary measures were followed. The evacuation decision was judged to be justified.

Question 5. In your assessment, were the actual emergency responses and follow-up adequate?

Have a debate on how the manner in which this emergency was handled relates to the type of response that could be launched in your own community. Is there emergency preparedness and a response team? If this is not known, the students might want to find out the details.

Question 6. What risk communication issues can you identify?

Many citizens and fire-fighters will be quite worried. An approach to risk communication is needed that is sensitive to how people feel about PCBs and dioxins. Dioxins are usually referred to incorrectly as one of the most toxic substances known; this is true for guinea pigs but not for humans. An issue such as the continued benefit of breast-feeding when there is some risk of contamination requires careful thought and communication sensitivity.
Question 7. What follow-up measures do you recommend?

Medical follow-up of the most exposed individuals, namely the frontline response team (i.e. fire-fighters, police, clean-up crews) seems warranted. Periodic biological monitoring would assess the loss of the persistent pollutants from the blood compartment. An official enquiry about safeguards and regulations associated with storage of dangerous chemicals appears necessary. High temperature incineration appears to be a suitable disposal alternative for PCBs.

Selected references


Learner, peer and problem evaluation

Formative evaluation
At the end of each session, but especially after the last one, allow participants to express their thoughts and feelings about their own participation and progress, as well as about the contributions and roles of the instructor/facilitator and fellow learners. Solicit comments about the approaches used (i.e. debate, role-playing, other). A written or oral evaluation concerning achievement of the stated objectives is also a good idea. Can the problem as presented be improved? How?

Summative evaluation
A test with questions that require short essay answers (e.g. 4-5 lines) and which explore the learners’ knowledge, understanding and ability to apply the new knowledge inherent in the study objectives might be tried. Alternatively, have the students prepare an investigative/critical assessment of a major environmental health risk in their own community and the local state of preparedness for dealing with an emergency situation and follow-up.
4.2. Problem-solving exercise: mercury poisoning in the Amazon
Adapted from A. Yassi, D. Mergler and E. Nieboer

 предпочитаемый Tempo: One 30 minute session, and one 2-3 hour block

✓ Objectives:
At the end of the exercise, students will be able to:
1. Review the principles of risk management: assessment, perception, communication, reduction and prevention.
2. Encourage community participation in research projects and develop effective risk communication strategies.
3. Acknowledge the need for scientific data and cultural sensitivity in the formulation of occupational and public health decisions.
4. List the measures for mercury-containment and prevention of exposure.

✍ Procedures:
1. Introduce the exercise and review its objectives. Divide participants into small groups (4-6 people). Instruct participants to identify a chairperson and a recorder. The students should define issues and distribute tasks before the 2-3 hour classroom session.
2. Distribute the exercise and review the participants' tasks. It may be preferable to assign a certain number of questions to the group and then reconvene to ensure that all are proceeding well.
3. Reconvene the groups and invite a response from one group to the first question. Ask whether other groups have any different responses. Summarize and, if necessary, expand on the participants' responses and proceed to Question 2. Allow a different group to initiate the discussion and continue in this way until all questions have been answered. Possible answers to the questions are provided below. These answers are not all-inclusive. Instructors are encouraged to develop alternative responses and intervention strategies that are appropriate to the local situation.
4. Summarize the results, emphasizing key messages.

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Case scenario

Gold mining in Brazil has been associated with a wide variety of concerns, especially contamination of the environment with mercury (Pfeiffer et al., 1993). Most of Brazil's gold is produced by non-organized prospectors called garimpeiros. After gravimetric preconcentration, amalgamation is carried out by passing a water slurry of the ground ore over mercury-coated copper plates to which the gold particles adhere. Periodically, the gold-mercury amalgam is scraped off. The gold itself is recovered by heating, which is carried out by distillation in the local towns, in huts beside the river, or by driving off the mercury to the air by direct heating at river banks without any containment or personal protection. There are approximately 1 million garimpeiros in the Brazilian Amazon, generating the release annually of about 130 tons of mercury to the environment; of this, it is estimated that 65-83% is released to the atmosphere and the remainder to soils or rivers (Pfeiffer et al., 1993).

Metallic mercury in the environment is transformed after oxidation into methylmercury by the activity of bacteria present in soil, sediments and suspended particulates in water. Organic mercury is highly assimilable into the trophic chains where it can be biomagnified a million-fold between initial transformation and the ultimate predatory species. (You will learn more about biomagnification in Chapter 7.) Fish with mercury concentrations exceeding the 0.5 µg/gm have been caught downstream from the gold mining area (Malm et al., 1990).

On the Tapajos river system where extensive gold mining efforts have focused (see Box 11.5 in the textbook), a physician working in the area became concerned. He was assessing the effect of mercury vapour on gold miners and his positive findings led him to wonder whether the communities living downstream of the gold mining activities might be at risk from methylmercury exposure. Both psychological and neurological symptoms are associated with chronic exposure to mercury vapour (IPCS, 1991). Acute inhalation results in interstitial pneumonitis. Mercury concentrations in whole blood reflect current and recent exposures to inorganic mercury (usually experienced as mercury vapour). The time required for the lowering of inorganic mercury in the blood compartment by a factor of 2 (t\textsubscript{1/2}) is 3 days, with a minor decay component characterized by t\textsubscript{1/2} = 30 days. Methylmercury poisoning results in a neurological disorder called Minamata disease, which first occurred in the 1950s following mercury contamination of Minamata Bay, Japan (IPCS, 1990; see boxes 4.9 and 7.5 in the textbook). The exposure levels in that situation, however, were thought to be considerably higher. Total mercury level in hair and whole blood constitute good exposure indices to methylmercury. On average, the hair-to-blood concentration ratio observed is 250 (IPCS, 1990; Akagi et al., 1995). In both matrices, it is present primarily as the alkyl compound. National health agencies use 10-20 µg/g total mercury in hair (equivalent to 40-80 µg/L in whole blood) as the maternal concentration range for which some risk exists of neurological/developmental effects in neonates, with 6 µg/g in hair and 20 µg/L in whole blood as having no adverse effect or safe levels. For methylmercury, t\textsubscript{1/2} values for its removal are 45-70 days for the whole-body, blood or hair compartments.

**Question 1. What do you know about mercury poisoning (refer to Chapters 2 and 9 if necessary).**

It was brought to the physician's attention that there was an agreement concerning environmental sciences between the Universidade Federal do Para and the Université du Quebec à Montréal (UQAM). The Brazilian group was particularly interested in building up its expertise in this area and in establishing a laboratory capable of measuring mercury on a regional university campus.

IPCS (1990) and IPCS (1991) provide excellent summaries of the toxicology of methylmercury and inorganic mercury, respectively. The latter includes...
mercury vapour and mercurous and mercuric (Hg$_2^+$) salts. Briefly, mercury salts are corrosive and damage most tissues they come into contact with. When ingested and absorbed systemically, complex nephritis (i.e. kidney inflammation) results and the neurological effects resemble those of mercury vapour. Acute inhalation of mercury vapour results in severe pulmonary damage as well as kidney injury. Chronic effects produce weight loss, fatigue, anorexia and gastrointestinal complaints. As inorganic mercury poisoning progresses, three main effects are gingivitis, tremors and increased excitability (erethism). By contrast, Minamata disease due to exposure to methylmercury constitutes a progressive nervous system syndrome that involves: numbness and tingling of lips, tongue and distal extremities; loss of motor coordination with gait ataxia, tremor; loss of fine movement, muscular rigidity and even seizures; constriction of the visual fields, hearing loss, speech disturbances, coma, followed by death.

**Question 2. What types of environmental and health assessment studies might be carried out? (Review Chapter 3 if necessary.)**

The researchers decided to examine the origin, transportation and pathways of mercury poisoning and to look at indicators of health deterioration consistent with methylmercury exposure among riverbank populations.

Mercury levels in the air, soil, river and drinking water, sediments and aquatic organisms (especially fish) had to be assessed. Exposure of garimpeiros to mercury vapour could be assessed by whole-blood mercury levels and that of villagers to methylmercury by whole-blood and hair mercury. Speciation-specific analytical protocols are available to distinguish between total mercury and methylmercury contents in both these matrices. This distinction can be helpful in identifying the mercury source (i.e. whether exposure is to mercury vapour in the air or to methylmercury in fish). In the absence of overt clinical symptoms of mercury exposure, early indications of nervous system deterioration using quantitative neurobehavioural and neurophysiological measurements constitute a sensitive health outcome.

**Question 3. Should developed countries be involved in this sort of problem assessment?**

A debate is suggested for this issue.

**Question 4. What professionals (disciplines) should be involved? Who else should participate?**

In March 1994, the research team principals (the physician, a neurotoxicologist, an environmental biologist, a cytogeneticist, a biogeochemist and an analytical chemist) met with the leaders and community health agents of two villages on the Tapajos River. The researchers proposed a public meeting to explain the objectives of the planned study to the villagers and emphasized that a limited number of the village’s 450 inhabitants would be selected for the human health component.
It is clear that an interdisciplinary team is required.

**Question 5. What questions might the villagers have?**

The villagers had the same questions that other exposed groups have. More specifically, they wanted to know who would inform them of the results and what solutions there might be. Of the 40 people asked to participate, 39 responded positively. None was working as a garimpeiro. A battery of tests designed to examine early changes in nervous system functions, consistent with our knowledge of methylmercury poisoning, were administered under standard conditions to provide quantitative measurements of nervous system dysfunction which could be examined with respect to hair mercury levels. Samples were taken from the soil, sediment, water, foliage and fish in order to identify the source of exposure.

**Question 6. Should the details of the results be shared with villagers? How might this be achieved?**

A year later, the researchers presented their preliminary results to the community health coordinators and village leaders. It was intended to ask advice from the local officials on how to present the results in the social and cultural contexts of the villagers (Wheatly, 1996). In a public meeting, the leaders were informed that, in spite of the small number of subjects studied, there were significant reductions in visual and motor functions that appeared to be related to the quantity of mercury in hair, which varied from 6 µg/g to 38 µg/g among the study group (geometric mean of 14 µg/g). More technically speaking, statistically significant correlations were observed between hair mercury levels and loss of colour discrimination capacity (p = 0.05) and manual dexterity (p < 0.01, females only) (Lebel et al., 1996). Convincing evidence was also obtained from colleagues at the Universidade Federal do Rio de Janeiro about the contamination by mercury of river water, soil, sediments and fish (Mal et al., 1990; Nriagu et al., 1992; Pfeiffer et al., 1993).

A role-play would help to define the villagers' questions and risk communication issues. The cultural and social context needs to be addressed. The article by Wheatley (1996) might be helpful.

**Question 7. Based on the information provided, estimate the dose (risk) ratio.**

Although rather simplistic, the mercury hair levels might be compared with the no-effect, "safe" level (NOAEL): Dose (Risk) Ratio 2.3 ranging 1.0 to 6.3
Question 8. Should a follow-up study be planned? Should the villagers be part of this decision?

Given the positive results of the preliminary study the research team returned in March 1995 to plan a full-scale study of a larger cohort. They learned that in the intervening year other researchers from Japan, the United States and Europe had been there and had taken hair and blood samples and performed neurobehavioural testing on the children. The response to the UQAM Brazilian investigators was: "Why should we participate in yet another study?" "What will we gain from it?" "Foreign scientists come, take bits and pieces of us and never return!"

A follow-up study of a larger number of subjects is warranted in order to establish NOAELs with greater certainty. Neonates might also be more closely examined for developmental impairments. Since this goal involves the participation of the villagers, they need to be consulted. A role-play approach might again be helpful. (The full-scale study has recently been completed and has confirmed that visual and motor functions were indeed affected by methylmercury in a dose-related fashion.)

Question 9. What should the UQAM/Brazilian team say now?

The investigators explained that it is probably a good thing that several studies are being done in this area since if many studies show that there is a problem then actions can be initiated more rapidly. They informed the villagers that all the studies of their research group were carried out in close collaboration with the exposed populations and that this one would not be different.

Although one answer is provided, other arguments to justify the research might be considered. Have a debate!

Question 10. What might be some short-term solutions and what might they tell the community now?

The investigators discussed with the community feasible and realistic options for reducing mercury levels. They visited the homes of all participants and gave them the information on their hair mercury levels, answering questions and discussing solutions. On the last morning the teachers invited the investigators to address students to explain the study. "Where is the mercury?" asked the investigators. "In the fish!" the students answered. "And what can we do?" "Eat more fish that don't eat other fish."

Because of biomagnification, piscivorous fish may be expected to exhibit the highest methylmercury concentrations. This has been confirmed (Nriagu et al., 1992). The size of edible fish is another parameter that is considered in fish consumption advisories; not surprisingly, the mercury content increases with size or age. For example, in Cameron Lake in southern Ontario, Canada, walleye fish species up to 35 cm in length have no long-term restrictions on consumption since the mercury levels are <0.5 µg/g; for those of length 35-55 cm, intake should be limited to 0.2 kg/wk because mercury levels are between 0.5-1.0 µg/g; the limit is 0.1 kg/wk for lengths 55-65 cm, with average
mercury concentrations of 1.0-1.5 µg/g; and no consumption is allowed at all for larger fish (mercury exceeds 1.5 µg/g).

Question 11. What occupational and environmental preventive measures might be implemented? Use the perspectives "at the source", "along the path" and "at the person" in your deliberations. Environmental, biological and health effects monitoring, as well as alternative gold extraction procedures, should be considered.

(i) Containment at the source. Both the exposure of garimpeiros to mercury vapour and its release to the ambient air could be curtailed by improved containment during the amalgam heating stage. Obviously, the discontinuation of the direct heating procedure to drive off the mercury should be encouraged. Extraction procedures without amalgam formation are also possible, although they will bring their own environmental contamination concerns (e.g. extraction with cyanide; Cohn and Stern, 1994). Deforestation is also suspected of contributing significantly to the mobilization of mercury both from anthropogenic sources and present naturally in soils (see Box 11.5 of the textbook). This complicates containment strategies.

(ii) Containment along the path. Every effort needs to be made to prevent the contamination of soils, sediments and water with mercury. Mercury-rich tailings need to be processed further (e.g. extraction of mercury with cyanide) or disposed of in a manner that ensures containment and stability (e.g. through revegetation).

(iii) Containment at the target/person. Personal protection for the garimpeiros, such as a suitable respirator, may be needed even if the mercury distillation from the amalgam is contained. Portable air monitoring devices for mercury vapour are available to monitor exposure levels. It is unlikely that personal protection and environmental monitoring are realistic for the garimpeiros. Fish consumption advisories would help considerably in reducing methylmercury intake for the villagers, although this may not be realistic or socially acceptable.

Clearly, continuous environmental and biological monitoring are required to ensure the implementation of effective protective and preventive actions. Clinicians should be on guard for clinical evidence of exposure, especially in newborns.

Question 12. How is it useful to link occupational and environmental health here? (You may wish to review the section in Chapter 1 that addressed this.)

This case study demonstrates that industrial activity often contaminates both the work environment and the general environment. In such cases, occupational health and environmental health are inherently connected and so are the solutions. This heightens the need for hazard control and management. Although in the case considered the forms of mercury the workers and villagers were exposed to were somewhat different, there was enough overlap
in health outcomes (e.g. nervous system dysfunction) for both types of exposures to be carefully documented in epidemiological studies.

**Question 13. Is this problem a local one? Could it happen in developed countries? Is there a reason for global concern about mercury contamination?**

A little literature research indicates that mercury contamination is a global problem. Volcanic activity, oceans and weathering of the earth's crust (which is enhanced by acidification and flooding) are natural sources of mercury. The world wide oceanic output of elemental mercury is estimated at about 30-40% of the annual atmospheric Hg-emissions; microbial activity is primarily responsible by converting mercury ions (Hg²⁺ or Hg⁴⁺) to mercury vapour. Long-range transport has been established. These components of the mercury cycle explain the contamination of fish in lakes far-removed from industrial activity such as in northern parts of Canada where fish-eating native communities have been affected.

**Learner, peer and problem evaluation**

**Formative evaluation**

At the end of each session, but especially after the last one, allow participants to express their thoughts and feelings about their own participation and progress, as well as about the contributions and roles of the instructor/facilitator and fellow learners. Solicit comments about the approaches used (i.e. debate, role-playing, other). A written or oral evaluation concerning achievement of the stated objectives is also a good idea. Can the problem as presented be improved? How?

**Summative evaluation**

Devise a test, preferably incorporating a new problem scenario, to examine the learners’ knowledge, understanding and application of the new knowledge inherent in the study objectives.
Selected references


4.3. The role of community involvement
Prepared by Merri Weinger

⏰ Time: 2 hours

✓ Objectives:
At the end of the exercise, students will be able to:
1. Define the purpose of community involvement in environmental health issues.
2. List three barriers to effective community involvement.
3. List three strategies for improving communication with the community about environmental health.

☞ Procedures:
Community involvement questionnaire (20 minutes)
1. Ask students to complete a brief questionnaire which addresses attitudes to community involvement and obstacles to effective communication (Annex 8).
2. When students have completed the questionnaire, facilitate a group discussion about their responses. Ask for a show of hands as you read each statement and each response. Encourage volunteers with different responses to justify their response. As the instructor, try to avoid making a definitive statement about the "correct" attitude. Instead, encourage participants to consider all points of view.
3. Conclude with a discussion of the barriers to and benefits of community involvement. Write out a list of each on large pieces of paper.

Suggestions for involving the community in environmental/occupational health issues (20 minutes)
1. Define risk communication (i.e. the range of interactions with the community about environmental hazards and potential health risks.) Interactions may include: presentations or workshops, community meetings, advisory committees, telephone conversations, use of mass media, and written or audiovisual materials.
2. Review tips for involving the community and communicating more effectively about environmental and occupational health risks:
   - Pay as much attention to the non-technical factors that influence how the community perceives risk as to scientific variables. (But don't underestimate the community's ability to understand the science.)
The risks that elicit public concern may not be the same as the ones that scientists have identified as most dangerous to health. For example, voluntary risks are accepted more readily than those that are imposed (e.g. an individual decision to smoke versus exposure to air pollution). Natural risks (e.g. earthquakes) seem more acceptable than artificial risks (e.g. from industrial sources). A chemical with a strong odour is perceived to be more hazardous than an odourless chemical.

- As far as possible, involve the community in the decision-making process on the environmental issues that affect them.
  - Involve everyone who has an interest in the issue.
- Listen to the community's specific concerns.
  - Try to identify with your audience; put yourself in their place.
- Provide adequate background when explaining risk numbers.
  - If you are explaining numbers derived from a risk assessment, explain the risk assessment process before you present the numbers.
  - Make sure to show the routes of exposure using clear and simple graphics. Frequently, the issue is not whether a dangerous substance exists in relatively high quantities, but whether the routes of exposure put people at risk.
  - Speak clearly and use simple, non-technical language.
  - Always try to include a discussion of actions that are in progress to address an environmental health problem. Be sure to let people know what you can and cannot do.

3. Ask participants to add any suggestions that have not been mentioned.

**Role-play and discussion of risk communication scenario (1 hour and 20 minutes)**

1. Distribute risk communication scenario to the group. See sample risk communication scenario (section 4.3.2. at the end of this exercise).

2. Explain the exercise. Two students will play the role of agency representatives who will make a brief presentation to a community meeting about the health risks and plan of action of the agency. The other participants will play people attending the meeting. Brainstorm a list of potential attendees (government leaders, local residents, legislators, environmental group, press, chamber of commerce, etc.) and ask the group to anticipate the questions and concerns of each group.

3. Identify two volunteers who will develop and deliver a five-minute presentation to the community group to be followed by 5-10 minutes of questions from the audience. Volunteers leave and prepare their presentation (15 minutes).
4. During this time, the other participants select roles from among the list of potential attendees and formulate questions or comments for agency representatives (e.g. local resident: "What about our children? Did you have any plans for how they will be protected?")

5. Identify two observers who will not assume roles, but will observe and evaluate the speakers on the basis of a list of criteria such as:
   - Was the presentation clear and comprehensive?
   - Did the speakers adequately address the audience concerns (especially the non-technical factors described above)?
   - Was the "body language" appropriate (e.g. eye contact, posture, gestures)?
   - Were you satisfied with the explanation of risk and the proposed plan of action?

6. When the volunteer speakers return, review the criteria which will be used for evaluating the meeting. Instruct the speakers to convene and run the meeting. Inform the team when the time for both the presentation and the question and answer period is over.

7. Following the "meeting", discuss the strengths of the presentation and areas for improvement. Invite speakers to comment on their experience first, then observers, then open the discussion to the whole group.

8. Conclude by asking participants to state something they learned from the risk communication session that they might be able to apply if faced with a similar situation in the future.

Alternative

An alternative to conducting a community meeting (role-play) in the classroom is to analyse the scenario in small groups using a worksheet (Annex 11). The groups are then invited to share their responses in plenary.

⊆ Materials:

Student’s questionnaire (Annex 9), risk communication scenario, evaluation criteria on flip chart, coloured markers, tape.
4.3.1. Worksheet questionnaire: introduction to risk communication

**Question 1.** Communicating with the public about health risks is more likely to unduly alarm people than keeping quiet.

Agree______ Disagree______

Why?

Communicating with the public about health risks may provide people with an opportunity to express their concerns, but not giving people this opportunity is likely to increase rather than decrease alarm. It is better to initiate communication with the public earlier (at the beginning of a health investigation) rather than later. In this way, a positive relationship between the agency (e.g. the Ministry of Health) and the public has a better chance to develop.

**Question 2.** We should not go to the public until we have solutions to occupational or environmental health problems.

Agree______ Disagree______

Why?

Problems can seem easier to deal with when coupled with solutions. But failing to involve people in decisions that affect their lives may result in tremendous opposition. People should be given background on the uncertainty of the science so that they do not assume that something is wrong if the agency does not know all the answers. The agency should explain what is being done to find answers.

Because people feel more comfortable about risks over which they have control, it is important to find ways to involve them in problem-solving on an environmental health issue. Encouraging community monitoring of the problem, as well as providing a contact person to call for information or to report problems, can help people exert more control over risks and thus feel more comfortable with them.
Question 3. The best way to determine which hazards or risk situations require scientific attention is to listen to those affected by the occupational or environmental problems (e.g. workers or community members).

Agree _______ Disagree _______

Why?
The affected community can be an important source of information when approaching an environmental pollution problem. Workers and community members have often been the first to identify a potential hazard in their environment and propose potential strategies for resolving the problem.

Question 4. Environmental health issues are too difficult for the public to understand.

Agree _______ Disagree _______

Why?
Environmental health issues can be very complex but, as demonstrated by citizen's groups in many parts of the world, lay people can learn a great deal about technical topics that are of importance to them. For example, citizens have successfully organized themselves to call into question the construction of new, potentially polluting industries or hazardous waste sites in their neighborhoods.

Question 5. If we could explain risks clearly enough, people would accept them.

Agree _______ Disagree _______

Why?
Explaining risks clearly is important, but data are not the only factors which influence people's perception of risk. For example, while scientists may discuss a low level of risk which is "acceptable", the community may feel that no level of risk is acceptable. People may also be outraged that they must be subjected to a certain risk (e.g. industrial pollution) which is beyond their control. It is important to pay attention to these other factors when communicating with people about environmental health risks.

Question 6. I see risk communication as an important part of the environmental health specialist’s job.

Agree _______ Disagree _______

Why?
Although the environmental health specialist may be hired for another function, risk communication should be an important part of the job of anyone involved in both occupational and environmental health and public service. In the course of their work, environmental health professionals should be able to communicate effectively about potential health risks with a variety of groups and individuals (e.g. workers, community residents, representatives of government and industry, policy-makers and health professionals).

4.3.2. Community involvement scenario

(Note: This scenario is based on a recent waste management assessment conducted by the World Health Organization Regional Office for Europe in two Romanian cities, Timisoara and Brasov. For the purposes of this exercise, data from both cities as well as other sites has been incorporated. The exercise has been adapted and used successfully in Jordan, South Africa and Thailand, indicating the relevance and timeliness of landfill siting issues around the world.)

Timisoara is a medium-sized city in the western part of Romania. It is an important border crossing to the former Yugoslavia. The municipality of Timisoara plans to construct a centralized solid waste landfill for use by city residents and suburban settlements. Currently, solid waste is being disposed of in an open landfill together with street and commercial waste, industrial waste (hazardous and non-hazardous) and hospital waste.

Plans for the new site emerged from a study which found that the current site poses a series of environmental health risks. It is inadequately located near urban dwellings; is not equipped with the necessary facilities such as bottom liners, drainage system, fencing and monitoring walls; is overloaded; and allows for the co-disposal of domestic waste with industrial hazardous waste and for the disposal of new materials and chemicals that are not biodegradable, are persistent in the environment or whose behaviour in the environment is unknown.

The proposed new landfill is close to the highways and would serve approximately 50% of the population. Since the siting of this new landfill is extremely controversial, the municipality of Timisoara has called a meeting with representatives of the community to address the concerns about the proposed new facility. At the meeting, you will represent the municipality. Your job is to inform the community about the utility of the proposed new landfill, explain potential health risks and anticipate and address any other concerns.

What follows is a list of the arguments supporting and opposing the construction of the facility which may be raised at the meeting.

Arguments supporting the solid waste landfill (agency perspective)

1. The site is accessible to major urban centres and suburban settlements for their solid disposal needs, yet distant from residential areas. (The closest population centre is 2 km from the site.)

2. The site is a pre-excavated pit which was formerly a clay extraction area for a brick factory. The pit is ideal for a disposal site since this land is otherwise unusable. The former excavation also provides an abundance of soil for lining the landfill and covering the layers of waste. The soil contains more than 70% silt and clay in the proper combination to prevent leakage into groundwater.

3. The site has a supportive climate with an evaporation rate which almost doubles the rainfall in the area.

4. Smells from the site will be minimized by covering the garbage with soil daily, by constructing a fence around the site to prevent wind and by planting trees in the area.

5. The site will be closely regulated, including periodic sampling of groundwater. Any leachate will be handled using the latest mechanical and scientific interventions. In addition, the site will be staffed for 16 hours a day to prevent improper dumping.
6. Alternative sites are not feasible due to the high costs of land purchase or the high cost of transport to remote areas.

7. If this centralized facility is not constructed, each community will construct its own facility (in as many as 17 sites), multiplying the potential for environmental pollution close to population centres.

Arguments opposing construction of the solid waste landfill (community perspective)

1. The site is too close to population centres - just 2 km away.

2. The land for the proposed site is the subject of litigation between Sag commune and Timisoara city. Members of Sag commune feel that the land should be returned to them.

3. The site will smell bad - just like the old landfill.

4. The site will pollute the groundwater.

5. Nearby landowners are concerned that they will never be able to sell property in the vicinity of the landfill. Their property will be worth nothing.

6. The scavengers who live around the old landfill oppose the construction of a regulated site. They earn their livelihood by collecting and selling discarded aluminum and metals from the old site. With a regulated site where open entry is prohibited, how will they live?