Annexes
ANNEX 1

Pre-workshop questionnaire
Workshop on basic environmental health

Please complete this questionnaire to help us in our workshop planning.
We request that you forward completed questionnaires by              to               :

1. Family name: First name:

2. Position or function within your institute:

3. Department/Institution:

   Address:

   Telephone: Telefax:

4. List any courses in environmental health and epidemiology that you have taken. Include university courses (undergraduate and/or postgraduate), short courses and workshops. Describe the target population for these educational activities (e.g. environmental health students, government officials, health personnel, community residents, etc.).

<table>
<thead>
<tr>
<th>Educational programme</th>
<th>Target population</th>
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</tbody>
</table>

5. What knowledge and skills would you like to acquire at this workshop?

6. Can this knowledge and these skills be applied in your work or other activities?
   If so, how?
ANNEX 2
Selected bibliography


Yassi A, Kjellström T, de Kok T, Weinger M. Teaching basic environmental health in universities utilising an interdisciplinary holistic approach and interactive learning methods. Ecosystem Health. Vol 3(3) 1997: 143-153

References on participatory teaching methods


Srinivasan L. Bridging the gap: a participatory approach to health and nutrition education. Save the Children, 54 Wilton Road, Westport, CT 06880, USA, 1982.


Visualization in participatory programmes: a manual for facilitators and trainers involved in participatory group events. UNICEF, P.O. Box 58, Dhaka 1000, Bangladesh, 1993.

Werner D, Bower B. Helping health workers learn. Hesperian Foundation, P.O. Box 1692, Palo Alto, CA 94302, USA, 1984.
### ANNEX 3

#### Teaching methods chart

<table>
<thead>
<tr>
<th>Teaching methods</th>
<th>Strengths</th>
<th>Limitations</th>
<th>Objectives achieved</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lecture</td>
<td>Presents factual material in direct and logical manner. Contains experiences which inspire. Stimulates thinking to open a discussion. Suits large audiences.</td>
<td>Experts may not always be good teachers. Audience is passive. Learning difficult to gauge. Needs clear introduction and summary. Needs time and content limits to be effective.</td>
<td>Knowledge</td>
</tr>
<tr>
<td>Worksheets and questionnaires</td>
<td>Allow people to think for themselves without being influenced by others in discussion. Individual thoughts can then be shared in small or large groups.</td>
<td>Can be used only for short period of time. Handout requires preparation time.</td>
<td>Knowledge Attitudes</td>
</tr>
<tr>
<td>Brainstorming</td>
<td>Listening exercise that allows creative thinking for new ideas. Encourages full participation because all ideas are equally recorded.</td>
<td>Can become unfocused. Needs to be limited to 10-15 minutes.</td>
<td>Knowledge Attitudes</td>
</tr>
<tr>
<td>Planning deck</td>
<td>Can be used to quickly catalogue information. Allows students to learn a procedure by ordering its component parts. Group planning experience.</td>
<td>Requires planning and creation of multiple planning decks.</td>
<td>Knowledge</td>
</tr>
<tr>
<td>Audiovisual materials (films, slide shows, etc.)</td>
<td>Entertaining way of teaching content and raising issues. Keeps audience’s attention. Effective for large groups.</td>
<td>Too many issues often presented at one time to have a focused discussion. Discussion will not have full participation.</td>
<td>Knowledge</td>
</tr>
<tr>
<td>Problem-solving exercises</td>
<td>Develops analytic and problem-solving skills. Allows for exploration of solutions. Allows students to apply new knowledge and skills.</td>
<td>People may not see relevance to their own situation. Cases and tasks for small groups must be clearly defined to be effective.</td>
<td>Knowledge Social action Attitudes</td>
</tr>
<tr>
<td>Role-play session</td>
<td>Introduces problem situation dramatically. Develops analytical skills. Provides opportunity for people to assume roles of others. Allows for exploration of solutions.</td>
<td>People may be too self-conscious. Not appropriate for large groups.</td>
<td>Social action Attitudes</td>
</tr>
<tr>
<td>Report-back session</td>
<td>Allows for large group discussion of role-plays, case studies, and small group exercise. Gives people a chance to reflect on experience.</td>
<td>Can be repetitive if each small group says the same thing. Instructors should prepare questions to focus discussion so as to avoid repetition.</td>
<td>Social action Knowledge</td>
</tr>
<tr>
<td>Prioritizing and planning activity</td>
<td>Ensures participation by students. Provides experience in analysing and prioritizing problems. Allows for active discussion and debate.</td>
<td>Requires a large wall or blackboard for posting. Posting activity should proceed at a lively pace to be effective.</td>
<td>Social action</td>
</tr>
<tr>
<td>Hands-on practice</td>
<td>Provides classroom practice of learned behaviour.</td>
<td>Requires sufficient time, appropriate physical space, and equipment.</td>
<td>Behaviour</td>
</tr>
</tbody>
</table>

Source: Adapted from *Labor educator’s health and safety manual*, Labor Occupational Health Program, University of California, Berkeley, CA, USA.
ANNEX 4
Problem-solving exercise: the impact of *schistosomiasis haematobium* on women in Cameroon

Student's version

Exercise

In a village in Cameroon, 76% of the population is affected by schistosomiasis, with slightly more women infected than men. The disease is contracted by the passage of the parasite *Schistosoma haematobium* through the skin in water. The effects of the disease can include iron deficiency and anaemia if the infection reaches a level sufficient to cause loss of blood in the urine. The infection results in loss of appetite, fatigue and weakness, along with impaired ability to carry out domestic, agricultural and parental duties.

Other potential effects include genital lesions, as well as reproductive disorders which are particularly devastating for women in the community. Marriage opportunities for those affected may be diminished since potential suitors must be informed of the infection. Many believe that the infection is a venereal disease. Married women who are infected are forbidden sexual contact until they are cured and may even be evicted from the household.

Women's infection rates are linked to their domestic and agricultural responsibilities which include collecting water, bathing children, laundering, cleaning utensils, preparing and washing foodstuffs, and farming, all of which involve regular and prolonged exposure to infected water. Inadequate sanitation and waste disposal facilities, lack of basic amenities and lack of awareness concerning sources of infection and transmission are other causal factors.

Few villagers can afford the medication needed to treat the infection. Women in particular are disinclined to seek treatment, not only because of financial limitations but also because of the social stigma associated with the disease. Its persistent recurrence fosters the belief that schistosomiasis responds neither to traditional nor western medicine. For these reasons, it is likely that urinogenital schistosomiasis infections in women are significantly underreported.

Your task is to analyse this public health problem and identify potential solutions.

■ Question 1. What are the environmental issues or problems facing women in this case?

■ Question 2. What are the health effects of these problems?

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Question 3. What are the underlying causes of these problems?

a. Is this problem related to women's status in society?

b. Is the problem due to women's exposure to a certain hazard through performing obligatory tasks?

c. Do biological or physiological factors play a role in this problem?

d. Do women suffer more from the health problem once it occurs, such as through lack of awareness of its impact on them, social stigmatization or lack of access to treatment?

Question 4. What other information do you need to fully assess the situation?

What kind of health information is already available?

Is it gender-sensitive?

For what reasons have other groups (adolescent males) mostly been targeted for study?

Why is it thought that these groups are most at risk?

Given their traditional roles, has sufficient attention been given in the past to women's potential exposure?

Question 5. How would you go about investigating this problem in detail?

a. What cultural/gender issues need to be considered in planning further investigations/studies?
In the society under investigation, what work or other activities done by women are likely to expose them to the same or greater risks than other population groups?

What is the regularity and duration of women’s exposure, during all their roles and responsibilities, compared with that of other groups at risk?

Does exposure to this risk affect women’s ability to perform their roles in other spheres?

What kind of measures could be taken to ascertain whether women are unwilling or unable to report this disease?

b. Whom would you involve in your investigation team?

**Question 6. What can be done about the problem?**

a. What prevention measures or campaigns would you recommend?

b. Why and how would you involve women in your prevention efforts?

c. Why and how would you involve men in your prevention efforts?
ANNEX 5

Problem-solving exercise: environmental estrogens
Student's version

Prepared by Evert Nieboer*

Background
Steroid hormones are essential for the growth, differentiation and function of many tissues in both animals and humans. The International Agency for Research on Cancer (IARC) (1987) designates steroidal estrogens as used in estrogen replacement therapy as carcinogenic to humans. The risk of endometrial and breast cancers is increased. Environmental estrogens (xenoestrogens) bind to estrogen receptors and have estrogenic activity in model systems. As illustrated in Box 2.1, this group of chemicals includes nonsteroidal estrogens, polycyclic aromatic hydrocarbons, DDT, and a number of PCBs (congeners that have two adjacent nonsubstituted carbon atoms on at least one of the biphenyl rings, including a para position). In addition to being suspected of acting as promoters in the development of estrogen-mediated cancers in humans (Davies et al., 1993), such xenoestrogens are believed to disrupt the immune, nervous and endocrine systems (McLachlan, 1993; EHP, 1995). Considerable and convincing evidence exists that reproductive and developmental processes are impaired in wildlife (such as birds, fish, reptiles and mammals (Colborn and Clement, 1992; Colborn et al., 1993). Comparable causal links in humans are less convincing and still speculative, such as the role of xenoestrogens in an apparent decline in semen quality over the past 50 years (Sharpe and Skakkebaek, 1993; Carlsen et al., 1995; Sate, 1995). The evidence for the involvement of environmental estrogen mimics in the etiology of breast cancer is explored in the present case scenario.

Case scenario, Part I
In a recent prospective cohort study investigating the role of endogenous hormones and environmental factors in cancer development, 58 women with a diagnosis of breast cancer 1-6 months after they entered the cohort (14 290 participants from New York City, 80% Caucasian) were compared to 171 controls selected from the same cohort and matched for menopause status and age. Sera, taken at the time of enrolment between 1985 and 1991 when attending a mammography screening clinic, were analysed for a metabolite of DDT [2,2-bis(p-chlorophenyl)-1,1,1-trichloroethane], namely DDE [1,1-dichloro-2,2-bis(p-chlorophenyl)ethylene], and total PCBs (polychlorinated biphenyls). Limits of detection were 1 µg/L for DDE and 2 µg/L for total PCBs based on three times the standard deviation of the results from the lowest quality-control serum pool standard over the course of the analyses (n=18). DDE was 35% higher in patients than in control subjects (p=0.031), while PCBs were 15% higher (p=0.058). After adjustment for first-degree family history of breast cancer, lifetime lactation and age at first full-term pregnancy, conditional logistic regression analysis showed a four-fold increase in relative risk of breast cancer for an elevation of serum DDE concentrations from 2.0 ng/mL (10th percentile) to 19.1 ng/mL (90th percentile) (p=0.0037 for trend). Other potential confounders considered, but with no effect, were: body mass index, age at menarche, history of benign breast tissue, history of tobacco smoking and/or alcohol drinking, and race. The corresponding association for PCB levels was not significant (p=0.16). It was concluded that environmental chemical contamination with organochlorine residues may be an important etiological factor in breast cancer.

* Dr Evert Nieboer, Department of Biochemistry, McMaster University, Hamilton, Ontario, Canada
Chapter 2 Questions
1. In simple terms, describe how estrogens regulate the growth, differentiation or function of cells.
2. DDE and PCBs are persistent organic pollutants (POPs). What is meant by this?
3. How is DDT converted to DDE?
4. What is the likely source or exposure route of the organochlorines?
5. Comment on the use of serum PCB and DDE levels as measurements of exposure.
6. From the toxicokinetic perspective, does it make sense that duration of lactation is an important determinant in the study? Explain.

Chapter 3 Questions
1. The study considered in the scenario is a case-control study nested within a prospective cohort study. What are the salient features of these two types of epidemiologic study?
2. What are confounders?
3. Has selection bias been avoided?
4. What are the known risk factors for breast cancer?
5. Apply the rules of causation outlined in Table 3.3 to the study at hand.
6. Comment on the authors’ overall conclusion. Is it valid?
Case scenario, Part II

Two of the investigators of the study described in Part I, participated in a second study conducted in California (Krieger et al., 1994; also see Wolff and Toniolo, 1995). Again the hypothesis tested was that exposure to organochlorines is a risk factor for breast cancer. Study subjects belonged to a cohort of 57,040 women (46,629 white, 8,123 black and 2,288 Asian) who took a multiphasic health examination between 1964 and 1971, independent of concern about risk of breast cancer. Follow-up was conducted through December 31, 1990 to identify those with histopathologically confirmed primary breast cancer six or more months after their multiphasic examination. From among the women who developed breast cancer (1,805 white, 230 black and 62 Asian), a random sample of 50 women in each racial/ethnic group was selected, as were equal numbers of controls matched according to race/ethnicity, date of joining the medical care programme, year of multiphasic examination and age at that time, and length of follow-up. Matched analyses found no difference in DDE or total PCBs, although organochlorine levels were significantly higher (p<0.05) among black and Asian women compared to white women. The mean differences (95% confidence intervals) for DDE were 11.0 (4.3, 17.6) μg/L in the black women and 12.6 (4.3, 17.6) μg/L in the Asian women and, respectively, 0.8 (0.2, 1.4) μg/L and 1.4 (0.8, 1.9) μg/L for PCBs. The detection limits were as stated in Part I. These ethnic differences persisted even after adjusting for available confounders: age at and year of medical examination, body mass index, educational level, poverty level, place of birth (United States or elsewhere), pregnancy history (ever or never). Multivariate analysis showed the absence of a significant association (p<0.05) between exposure to organochlorines and breast cancer, regardless of length of follow-up, year of diagnosis and menopausal status. The conclusion was that the data do not support the hypothesis that exposure to DDE and PCBs increases risk of breast cancer.

Chapter 2 Questions

1. What do we know about the molecular basis of cancer?

2. Do you have any analytical concerns about the PCB and DDE measurements reported in Parts I and II?

3. Does the estrogen hypothesis make biological sense to you (e.g. in terms of nutrition or physiology)?

Chapter 3 Questions

1. Is there room for an environmental risk factor to explain breast cancer?

2. Does the “xenoestrogen hypothesis” of breast cancer make epidemiological sense? Return to your previous deliberations concerning the rules of causation. You might also consider that epidemiological studies of individuals occupationally exposed to much higher concentrations of PCBs or DDT/DDE do not show a higher incidence of breast cancer (IARC, 1987; Safe, 1995).

3. IARC (1987) designates DDT as Group 2B and PCBs as Group 2A carcinogens. Do the results of the two studies discussed suggest that these classifications ought to be upgraded? Justify your answer?

Selected references


Sharpe RM, Skakkebaek NE. Are estrogens involved in the falling sperm counts and disorders of the male reproductive system. Lancet 1993; 341:1392-1395.


ANNEX 6
Dose-response/dose-effect curves: transparencies

The figures on the following pages are designed to be photocopied and used in conjunction with Exercise 3.2: The Relationship Between Dose and Health Outcome: Dose-Response Versus Dose-Effect. Place each figure on the overhead screen with the title covered. After students have described the curve, confirm the correct response and reveal the title.
Figure 1
Dose-Response Relationship
Figure 2
Dose-effect Relationship

[Graph showing the relationship between degree of effect and carboxyhaemoglobin in blood (%). The x-axis represents carboxyhaemoglobin in blood (%), ranging from 0 to 80. The y-axis represents degree of effect, ranging from slight headache to death. Different levels of effect are indicated by specific points on the graph, showing an increasing trend as carboxyhaemoglobin increases.]
Figure 3
Dose-Response Curve for Various Health Effects of Lead in Children

- Decreased b-ALA D activity
- Increased ZPP
- Anemia
- Effect on the CNS
- Decreased nerve conduction velocity
- Palsy, colic pain, encephalopathy

WHO 96026
Figure 4

Dose-Response Between Occupational Sound Levels and Percentage of Workers with Impaired Hearing for Different Age Groups

- Non-industrial noise exposed factory workers
- General population

Sound level at work (dBA)

Percent Impaired

AGE
55 – 59
40 – 46
30 – 39
20 – 29

WHO 98028
Figure 5
Dose-Response Relationship Between Speed and Risk of Injury for Seat Belt Use and Non-use
Figure 6
Dose-Response Relationship Between Noise Level and Annoyance

- USEPA (1973)
- Schultz et al. (1976)
ANNEX 7

Problem-solving exercise: emergency response to a PCB fire
Student's version
Prepared by Evert Nieboer

A. General instructions

The problem scenario will be given to you in three consecutive parts.

Part I consists of a vignette.

Part II provides factual information to help you to understand the problem better.

Part III gives you the outcome. The decision to proceed to the next stage should be made jointly by students and instructor.

B1. Response to a PCB-fire emergency (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, Quebec, 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.

Question 2. What immediate actions should be taken and who should be involved?
B2. Response to a PCB-fire emergency (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}C_{ln} 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?

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?
B3. Response to a PCB-fire emergency (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?

Question 6. What risk communication issues can you identify?

Question 7. What follow-up measures do you recommend?
Selected references


Problem-solving exercise: mercury poisoning in the Amazon

Student's version

Adapted by A. Yassi, D. Mergler and E. Nieboer

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 concentration limit proposed as safe for human consumption by IPCS in 1976, 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 ($t_{1/2}$) is 3 days, with a minor decay component characterized by $t_{1/2} = 30$ 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, $t_{1/2}$ values for its removal are 45-70 days for the whole-body, blood or hair compartments.

* Dr Annalee Yassi, Occupational and Environmental Health Unit, University of Manitoba, Winnipeg, Canada
Dr Donna Mergler, Université du Québec à Montréal (UQAM), Canada
Dr Evert Nieboer, Department of Biochemistry, McMaster University, Hamilton, Ontario, Canada
Question 1. What do you know about mercury poisoning (refer to Chapters 2 and 9 if necessary).

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

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

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

Question 5. What questions might the villagers have?

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

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

Question 8. Should a follow-up study be planned? Should the villagers be part of this decision?

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

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

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.

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.)

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


ANNEX 9

Introduction to risk communication
Student's version

Instructions: Please complete this questionnaire.

1. Communicating with the public about health risks is more likely to alarm people unduly than keeping quiet.
   Agree________ Disagree________
   Why?

2. We should not go to the public until we have solutions to occupational or environmental health problems.
   Agree________ Disagree________
   Why?

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?

4. Environmental health issues are too difficult for the public to understand.
   Agree________ Disagree________
   Why?

5. If we could explain risks clearly enough, people would accept them.
   Agree________ Disagree________
   Why?

6. I see risk communication as an important part of the environmental health specialist’s job.
   Agree________ Disagree________
   Why?

ANNEX 10

Sample risk communication scenario

Prepared by Merri Weinger

Representatives of the Department of Health in Mexico will be attending a meeting with the community in the town of San Cristobal de las Casas, Chiapas. The purpose of the meeting is to address concerns about the proposed construction of a gas plant in the community. What follows is a list of the arguments, both supporting and opposing the construction of the plant, which will probably be raised in the meeting.

The job of the presenters is to inform the community about the utility of the plant, explain potential health risks, and anticipate and address any concerns.

Issues
Supporting construction of the plant  (Agency perspective)

1. The community needs gas for domestic and commercial use, as well as for industry.
2. Gas is a source of combustion that offers no risk when handled with caution.
3. In the 45 years that gas has been distributed, there have been 14 accidents inside the country's gas plants that have not affected the neighbouring residents.
4. Gas is not toxic. Its combustion produces a clean flame.
5. The plant's equipment complies with national and international safety standards.
6. The fire prevention system within the plant has been improved.
7. Gas plants are equipped with an emergency response plan, a security manual and trained personnel.
8. The Department of Health is vigilant in monitoring gas plants and in enforcing health and safety standards.

Opposing construction of the plant (Community perspective)

1. We don't want to risk an explosion like the one that happened in San Juan Ixhuatepec.
2. Gas is dangerous and toxic.
3. Since the odour of the gas is so strong, it seems there will be an explosion any minute.
4. The gas cylinders are in very bad condition.
5. There are other dangerous industries in our community and we don't want any more.
6. If the plant explodes, the town will be destroyed.
Instructions

You will be representing the Department of Health in the upcoming meeting and are preparing your presentation to the community. Using your list of tips for community involvement and the list of arguments supporting and opposing the solid waste landfill, please respond to the following questions in your small group.

1. As you see it, what is the problem represented in this scenario? What is the goal of your presentation?
2. Who do you think will attend the meeting and what are their primary concerns?

Think about the potential target audience(s) listed above as you respond to the following questions:

3. How would you explain the utility of the facility?
   List three concepts or ideas you want to make sure you get across.

4. How would you explain the health risk of the solid waste facility?
   List three concepts or ideas you want to make sure to get across.

5. What is the agency’s plan of action that you will be presenting to the community?
   List three concepts or ideas that you want to make sure to get across.

6. What obstacles might you encounter during the meeting and what will you do about them?

7. Can you think of any ways to prevent such a situation from becoming controversial in the future?
ANNEX 12
Problem-solving exercise: epidemic asthma²
Student's version

Prepared by: Ruth A. Etzel* 

Part I
Barcelona is a city of 1.7 million situated on the Mediterranean Sea.
During the last week of January 1986, several physicians contacted public health authorities to report an increase in the number of persons who had come to the emergency rooms of the four large urban hospitals seeking medical care for acute severe asthma. Specifically, on Tuesday 21 January 1986 a total of over 130 people had sought care at these hospitals for difficulty in breathing. Most of these people were thought to be suffering asthma attacks. The attacks struck very suddenly and caused such severe problems that 10% of the patients required ventilatory support and 2% died.

Question 1. What is asthma?

Question 2. Is this an epidemic of asthma? What further information do you need?

Question 3. Review of the hospital records reveals that the four hospitals treated 288 persons with asthma during January 1986. Now can you determine if this is an epidemic?

Question 4. Develop a preliminary case definition.


* Dr Ruth A. Etzel, National Center for Environmental Health, Centers for Disease Control and Prevention, Atlanta, GA, USA
Table 1. Number of persons over 14 years of age who presented with acute asthma to the city’s four hospital emergency rooms in the previous year (1985).

<table>
<thead>
<tr>
<th>Month</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>199</td>
</tr>
<tr>
<td>February</td>
<td>146</td>
</tr>
<tr>
<td>March</td>
<td>180</td>
</tr>
<tr>
<td>April</td>
<td>155</td>
</tr>
<tr>
<td>May</td>
<td>165</td>
</tr>
<tr>
<td>June</td>
<td>128</td>
</tr>
<tr>
<td>July</td>
<td>138</td>
</tr>
<tr>
<td>August</td>
<td>124</td>
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<tr>
<td>September</td>
<td>181</td>
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<tr>
<td>October</td>
<td>166</td>
</tr>
<tr>
<td>November</td>
<td>182</td>
</tr>
<tr>
<td>December</td>
<td>147</td>
</tr>
</tbody>
</table>

Question 5. Do you now have sufficient information to determine if there is an epidemic of asthma?

Table 2. Number of persons over 14 years of age who presented with acute asthma to the city’s four hospital emergency rooms in January 1986.

<table>
<thead>
<tr>
<th>Day</th>
<th>Number</th>
<th>Day</th>
<th>Number</th>
<th>Day</th>
<th>Number</th>
<th>Day</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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<td>2</td>
<td>8</td>
<td>3</td>
<td>8</td>
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<tr>
<td>7</td>
<td>4</td>
<td>9</td>
<td>21</td>
<td>11</td>
<td>14</td>
<td>12</td>
<td>22</td>
</tr>
</tbody>
</table>

Question 6. Using the attached graph paper, draw a bar chart of the data tabulated above in Table 2. What additional information does the bar chart provide?
Figure 1. Number of persons seen in emergency rooms during January with acute asthma, Barcelona, 1986

Question 7. What other information would be useful to characterize the epidemic?

Question 8. On the attached city map, using dots, show the geographic distribution of the place of onset of illness (Table 3) for the 96 persons who came to the emergency rooms with acute asthma on 21 January. What does this distribution suggest?
Question 9. Using the attached graph paper, draw a bar chart of the cases by hour of occurrence (Table 3). What hypotheses are suggested?
Table 3: Data regarding age, sex, time and place of onset of illness, for each of the persons who came to the emergency room with acute asthma on 21 January 1986.

<table>
<thead>
<tr>
<th>Age</th>
<th>Sex</th>
<th>Time of onset</th>
<th>Place of onset (Region)</th>
<th>Age</th>
<th>Sex</th>
<th>Time of onset</th>
<th>Place of onset (Region)</th>
</tr>
</thead>
<tbody>
<tr>
<td>41</td>
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<td>40</td>
<td>M</td>
<td>10:00</td>
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</tr>
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<td>28</td>
<td>M</td>
<td>12:50</td>
<td>2</td>
<td>41</td>
<td>M</td>
<td>10:08</td>
<td>10</td>
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<td>27</td>
<td>M</td>
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<td>16:30</td>
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<td>11:15</td>
<td>2</td>
<td>28</td>
<td>M</td>
<td>11:50</td>
<td>2</td>
</tr>
</tbody>
</table>
Figure 3. Hourly distribution of admissions

Hours of Day, 21 January

Cases

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Part II

In your discussions with emergency room personnel, you learn that this is not the first time that the hospitals have been overwhelmed with patients suffering from acute asthma attacks. You are told that "asthma epidemic days" have occurred on 12 other occasions during the past two years.

Noting the clustering of asthma emergency room visits in space and time, you request data on air pollution in the city during the past two years. For Tuesday 21 January, air pollution levels were below normal for the city. The 24-hour average level of sulphur dioxide was 54 µg/m$^2$ and that of black smoke was 98 µg/m$^3$. The highest hourly mean for nitrogen dioxide was 10 ppb. Twenty-four hour pollen and spore counts were also below average for that time of year. Meteorological data showed high atmospheric pressure and stagnancy of the air with very low wind speed.

Question 10. What conclusions can you draw from this information?

Since many persons reported that they were affected in the centre of the city, near the waterfront, you decide to find out more information about the activities there. You learn that the following eight products were loaded or unloaded from barges and boats in the harbour during the past two years:

- coal
- gasoline
- fuel oil
- corn
- cotton
- soybeans
- coffee
- butane.

Question 11. How would you use this information to further explore this problem?

You ask for the dates on which each of these products were loaded or unloaded from barges or boats. This information is shown in Table 4.
Table 4

<table>
<thead>
<tr>
<th>Product</th>
<th>Days product is handled (Loaded or unloaded)</th>
<th>Days product is NOT handled (Loaded or unloaded)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Asthma epidemic days</td>
<td>Asthma epidemic days</td>
</tr>
<tr>
<td></td>
<td>NO</td>
<td>YES</td>
</tr>
<tr>
<td>Coal</td>
<td>196</td>
<td>4</td>
</tr>
<tr>
<td>Fuel Oil</td>
<td>150</td>
<td>3</td>
</tr>
<tr>
<td>Gasoline</td>
<td>180</td>
<td>2</td>
</tr>
<tr>
<td>Cotton</td>
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<td>7</td>
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<tr>
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<td>5</td>
</tr>
<tr>
<td>Corn</td>
<td>135</td>
<td>1</td>
</tr>
<tr>
<td>Soybeans</td>
<td>249</td>
<td>13</td>
</tr>
<tr>
<td>Butane</td>
<td>140</td>
<td>1</td>
</tr>
</tbody>
</table>

Question 12. Using the information in Table 4, complete the tables on the following pages and calculate the risk ratios. Optional: calculate the confidence interval (C.I.) for each table, using the formulas presented in class discussion. Also, the computer software EPIINFO may be demonstrated to calculate confidence intervals.

Question 13. How do you interpret the risk ratios and confidence intervals you have calculated?

Question 14. Now substitute a 1.0 for the 0 in cell B (soybeans) and re-calculate.

Question 15. How would you proceed from here?
**Figure 4. Risk ratios and confidence intervals based on Table 4.**

<table>
<thead>
<tr>
<th>Unloading煤</th>
<th>Unloading玉米</th>
</tr>
</thead>
<tbody>
<tr>
<td>Epidemic asthma day</td>
<td>Yes</td>
</tr>
<tr>
<td>RR (95% CI) =</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Unloading燃油</th>
<th>Unloading大豆 (1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Epidemic asthma day</td>
<td>Yes</td>
</tr>
<tr>
<td>RR (95% CI) =</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Unloading汽油</th>
<th>Unloading大豆 (2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Epidemic asthma day</td>
<td>Yes</td>
</tr>
<tr>
<td>RR (95% CI) =</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Unloading棉</th>
<th>Unloading丁烷</th>
</tr>
</thead>
<tbody>
<tr>
<td>Epidemic asthma day</td>
<td>Yes</td>
</tr>
<tr>
<td>RR (95% CI) =</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Unloading咖啡</th>
</tr>
</thead>
<tbody>
<tr>
<td>Epidemic asthma day</td>
</tr>
<tr>
<td>RR (95% CI) =</td>
</tr>
</tbody>
</table>

Risk ratio and 95% C.I. calculations were made using the EPI INFO software package, Version 5. USD, Inc., Stone Mountain Georgia, USA, 1990.  
95% C.I. are exact confidence intervals.
Part III

Question 16. Develop a strategy for prevention of asthma epidemics in the city.

Question 17. How would you assess the costs of this prevention strategy compared to the costs of the emergency visits for asthma attacks?


For further study of methodology for epidemiologic studies of asthma, the following review article is recommended: Anto JM, Sunyer J. Epidemiologic studies of asthma epidemics in Barcelona. Chest, November 1990 (Supplement): 185s-189s.
ANNEX 13
Problem-solving exercise: AECI/MACASSAR sulfur fire
Student’s version
Prepared by Stuart A. Batterman*

Part I
After several days of brush fires in the vicinity, a huge stockpile of sulfur caught fire late on a Saturday afternoon. The stockpile site belonged to AECI, the largest manufacturer of chemicals and explosives in South Africa.

Due to strong and persistent winds, the fire cannot be extinguished and a total of about 7000 tons of sulfur has already burned. While the fire site is several kilometres away from large population areas, the township of Macassar (population 40000) is 2.5 km downwind, and many suburbs of Cape Town (population 1.5 million) are 10-30 km distant. From about 21:00 on Saturday to 01:00 on Sunday morning, the most intense period of burning, the prevailing winds blow to the west-north-west.

Symptoms among residents in the vicinity of Macassar increase in prevalence and intensity up to midnight and beyond. Residents, mostly black, working class and poor, report a number of irritative effects (e.g. burning and irritation of eyes, nose and throat, coughing, shortness of breath, chest pain, stomach cramps and vomiting). Figure 1 shows the general area.

Figure 1. Map showing portions of Western Cape Province.
The smaller inset map shows a 6 km x 6 km region near the fire. “F” = fire site; “M” = sites of existing continuous SO₂ monitoring instruments; heavy dots = farms visited after the fire to investigate vegetative damage; shaded areas are mountains and/or nature preserves.

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Question 1. What happens when sulfur burns? What are appropriate protective levels for the resulting toxic gases? Can occupational and ambient air standards be used?

Question 2. What immediate steps should be taken to protect public health? What would you recommend?

Question 3. What information is needed to assess the situation and confirm your decision?
Part II

On early Saturday evening, residents of Macassar were told to stay indoors and to close doors and windows. Due to high winds (8-12 m/s), fire-fighting efforts were ineffective and the fire intensity increased. Macassar was directly downwind. Because the wind direction did not vary from about 20.00 to 01.00 in the morning, concentrations in even well sealed homes increased and exposures were prolonged. Residents began to experience increasingly intense discomfort, eye and skin irritation, breathing difficulty, gastrointestinal cramps and respiratory distress. Shortly after midnight, an evacuation of the town was attempted in a chaotic operation. Between 3000 and 5000 residents were moved to a shopping mall in Firgrove about 5 km distant. Most left after midnight. Despite this effort, approximately nine deaths occurred, including two men (both asthmatics) driving in opposite directions along a highway. In addition, between 1000 and 2000 people visited emergency respiratory clinics that were set up soon afterwards near the affected community, and approximately 15 people were later diagnosed with chronic asthma-like respiratory disease. The chemical company sponsored several emergency actions, including setting up local clinics where some health services (e.g. spirometry) were provided in the days and weeks after the fire.

**Question 4.** What information, if any, should be obtained from evacuees?

**Question 5.** What concerns might you have for the health of the evacuees?

**Question 6.** How might company sponsorship of the clinics affect their credibility and utilization?
Part III

In the days and months following the fire, a moderate amount of sampling and analysis was performed to investigate impacts related to the fire. Many residents suffering symptoms made repeat visits to local clinics. Symptom information was collected for about 1000 individuals, and spirometry was done on several hundred. Additional analysis was focused on ecological impact (e.g. impact on vineyards some 10-25 km distant).

Approximately one year later, the duration and extent of exposures on the nearby population were estimated using dispersion modelling. Using the best available data, air concentrations were predicted for each hour of the fire. Figure 2 depicts a Gaussian plume model imposed on a photo of the fire taken on Sunday morning (winds had considerably decreased and much of the fire was out by this time). The plume has Gaussian profiles, depicting the spread of pollutants in the crosswind and vertical dimensions.

Some of the dispersion model results are displayed in Figure 3 using “isopleths” or lines of equal concentrations (like contour maps). The maximum one hour concentration ranged from about 10 to 200 ppm, and much of the area was exposed to 100 ppm for one hour. Thus, levels appear to have approached or exceeded the IDLH value. Firgrove (where Macassar evacuees were accommodated) was in a relatively low concentration area. Note that the maximum hourly concentrations are not necessarily coincident in time, i.e. one cannot tell from the map what hour the exposure occurred. The second highest hourly concentrations ranged from 10 to 40 ppm, and the 24-hour averages were from 1 to 15 ppm. These estimates indicate that concentrations in the Macassar community exceeded by 20-1000 times levels designed to be protective of health.
Figure 2. Depiction of the plume resulting from the fire. The plume width and plume height follow Gaussian curves which are adjusted in practice (but not in the figure) to match characteristics of the fire’s plume. Such models allow concentrations to be estimated at many locations.
Figure 3. Isopleths showing the maximum 1 hour SO\textsubscript{2} concentrations in ppm in the Macassar area. The modelled area is 6 x 6 km, with the sulfur fire located in the south-east corner and designated “F”. The complex pattern results from wind shifts over the fire; most of the time, winds blew to the west-north-west.

Question 7. What is air quality dispersion modelling? What information is required?

Question 8. How can a modelling analysis be used?

Question 9. What are some of the uncertainties in dispersion modelling and the exposure assessment? What data would be useful?
Selected references


White N. A survey of the health effects on helderbug community of smoke exposure from a sulfur fire. Cape Town, University of Cape Town, 1996.