Chapter 6: Water and sanitation

6.1. Problem-solving exercise: water for Tonoumassé, a village in Togo
6.2. Role-play: waterborne outbreak in a Romanian town
6.3. Problem-solving exercise: water availability and trachoma
6.1. Problem-solving exercise: water for Tonoumassé, a village in Togo

Prepared by Evert Nieboer and Annalee Yassi

Adapted with permission from Water for Tonoumassé, Carleton (Ontario, Canada); Local Committee of CUSO

_startup Time:_ Two 1-hour sessions

✓ **Objectives:**

At the end of the exercise, students will be able to:

1. Define health, according to the WHO definition; describe the basic needs for human survival, the relationship between environmental factors and health, the significance of clean water as a determinant of health, the obstacles to resolving environmental problems, the nature and extent of waterborne diseases, and the major sources of water contamination.

2. Endorse or develop a holistic view of health and environmental health; appreciate gender tolerance and religious, cultural and social sensitivities; distinguish between community and individual rights, views and initiatives.

3. Appreciate the need to empower the community to recognize, define and resolve significant environmental health problems through teamwork, community spirit and individual responsibility and effort; promote public education about the link between safe water and good health.

gregator 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 case scenario has two parts. Both parts are followed by questions related to the material covered in Chapter 1 and Chapter 6 of the text. Distribute Part I and review the participants' tasks.

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. The decision to proceed to Part II should be made jointly by the students and the instructor.

**Materials:**

Problem-solving exercise (Annex 14), flip chart, coloured markers.

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**Case scenario, Part I**

Togo is a long and narrow country in Africa that stretches 580 km north from the Gulf of Guinea. It is flanked by Ghana on the west and Benin on the east. It has an average rainfall of 100 cm/year which is considerably less than that received in other tropical areas. The United Nations classifies Togo as a "least developed country". Tonoumassé is a village of about 100 inhabitants located 50 km or so north of the coastal capital of Lomé. The surrounding area is a mixture of forested land (teak, mahogany, bamboo) and agricultural land (small farms growing coffee, cacao and cotton). Regionally, about 18% of the people have access to safe drinking-water. Fetching water is considered "women's work". Women spend 1-4 hours daily in the wet season (March to July) and as much as 8 hours in the dry period (December to March) in walking the 15 km to the nearest river. While there, they wash the family's clothes and carry about 15 litres of water back to the village. Housework, child care, farming and handicraft production/sale needs to be taken care of after arriving home about midday. The water they collect is rarely safe. Drinking it can lead to a parasitical disease caused by the guinea worm, as well as typhoid, hepatitis, schistosomiasis, dysentery and other intestinal infections. As a result, up to 40% of the children die before the age of five. Those that survive miss a lot of school because of chronic illness. The ability of adults to work is also affected by parasitic disease and repeated infections. Not surprisingly, back ailments are prevalent among women.

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**Chapter 1 Questions**

1. **Meeting human survival needs is consistent with the UN Universal Declaration of Human Rights (1948). What obstacles exist in rural Togo to achieving this priority?**

   The answer to this question lends itself to a group discussion. The obstacles to a human right "to a standard of living adequate for the health and well-being of themselves and their family, including food, clothing, housing, health care and the necessary social services" are many. They include: poverty; poor health; apparent lack of resources; lack of local infrastructure and services; lack of clean water; lack of education (link between safe water and good health not understood); cultural/social practices (duties of women versus men, low expectations of female decision-makers).

2. **From the perspective of the WHO definition of health, what is the health status of the Tonoumassé villagers?**

   Judging by the mortality rate among children, the prevalence of chronic infectious diseases, the lack of social services, the mental anguish of losing loved ones, and the demanding tasks of fetching water and obtaining other essential items for survival, the health status of the Tonoumassé community is poor. A group discussion is suggested.
3. **Discuss the interaction between human activity in Tonoumassé and the biological environment.**

Clearly the presence of bacterial, viral and parasitic pathogens in the drinking-water reduces health and has a negative impact on all human activity including the ability to work (adults) or to attend school (children).

4. **Poverty is considered the greatest risk factor of poor health and a major obstacle to resolving environmental health problems. Discuss this in the context of Tonoumassé.**

Togo is a "least developed country" with a very low per capita income. Public services are absent and thus there is neither a central water supply nor adequate sanitation. Without treatment, the water that is available constitutes a serious health risk. This results in high prevalence of communicable diseases, high infant mortality rates, chronic poor health and short life expectancy. Outside help is needed to escape from this inevitable cycle of ill-health and poverty. Have a group discussion to bring out these points.

5. **Do you consider the women of Tonoumassé as a "vulnerable group" in terms of susceptibility to poor health? Explain.**

The women carry a superhuman burden as the primary providers, and this is accentuated by the physical demands of fetching water. About 15-20 kg need to be carried over long distances each day. Lack of proper rest, absence of recovery time and physical back injuries make the women more vulnerable to poor health.
Chapter 6 Questions

1. ■ Review the causes of the diseases mentioned.

2. ■ What categories of communicable disease linked to water appear to be involved in the case scenario?

<table>
<thead>
<tr>
<th>Disease</th>
<th>Pathogen</th>
<th>Type of water-related disease</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dracunculiasis</td>
<td>Dracunculus medinensis (guinea worm)</td>
<td>Water-based (ingested)</td>
</tr>
<tr>
<td>Typhoid fever</td>
<td><em>Salmonella</em> bacteria</td>
<td>Waterborne and water-washed (ingested)</td>
</tr>
<tr>
<td>Schistosomiasis</td>
<td><em>Schistosoma</em> flukes (trematode)</td>
<td>Water-based (penetrates skin)</td>
</tr>
<tr>
<td>Dysentery</td>
<td><em>Shigella</em> bacteria; the amoeba <em>Entamoeba histolytica</em></td>
<td>Waterborne and water-washed (ingested)</td>
</tr>
<tr>
<td>Hepatitis A, E</td>
<td>RNA virus</td>
<td>Waterborne and water-washed (ingested)</td>
</tr>
</tbody>
</table>

3. ■ The small wet season in the period September to December is disappearing in the maritime region of Togo. Within the context of water scarcity, what might be the cause? Is this development consistent with global trends?

Aridity is the only cause of permanent water scarcity that is due to a dry climate. Global warming might well explain the trend. The extensive agricultural land use could lead to water shortages through water-stress or desertification.

4. ■ Would water treatment have helped the Tonoumassé water problem? What might have been done?

The simple use of a chemical disinfectant such as a chlorinating agent would have made the water safer.

5. ■ What options other than water treatment might be considered?

Other options available to reduce the chance of infection include: elimination of unsanitary storage or use of water; protection of food
during preparation and storage; improved personal hygiene; and the use of sanitary latrines or toilets. Of course, drilling a local well might be a more effective option.

Case scenario, Part II

During the 1980s, the Government of Togo with the help of Canadian Universities Services Overseas (CUSO) initiated a rural water supply project. The village of Tonoumassé became aware of this through a female extension officer and, because there was dissatisfaction with the lack of water, appointed a committee. One of the requirements of the project was that at least half of the committee members should be women. The men grumbled and predicted failure, but grudgingly went along with the idea. Although pump installation was free, the villagers had to agree to clean the installation site, provide materials and labour for the concrete apron, send two people to learn how to maintain the pump, and to pay for all future repairs. A formal agreement was signed in a public ceremony in the presence of high-ranking government officials.

Tonoumassé villagers chose to set up a collective farm plot and required each family to contribute a day’s work per week. Sales of produce from this venture were 10 times more than was needed to cover the pump maintenance costs. Consequently, the village had a fund that could be used for other community improvements. Effectively this constituted the first local taxes Tonoumassé ever raised.

In eight general meetings for villagers and project managers (mostly female), rural extension workers and trained villagers took time to explain the connection between clean water and sanitary conditions and good health (including use of covered water containers, curtailment of the soiling of houses and yards, and a general programme to keep the village clean). A reduction in illness became apparent soon after the pump was installed and the concomitant improvements were made.

An interesting aside concerns respect for religion and culture. After consulting the spirits of the dead, village elders agreed with the modern-day technicians about the location of the water source and the placement of the pump.

Chapter 1 Questions

1. Was the requirement of female membership of the project committee a reasonable one?

2. Discuss the required contribution to the collective farm plot in terms of individual versus community initiatives/rights.
   A debate might be an effective way of exploring possible perspectives.

3. Empowerment is an important motivational principle. What was its role in the pump project and how was it achieved?

   It appears that the community bought into the project through training and education: villagers were enabled to understand the connection between safe water and sanitary conditions and good health. Their direct involvement in setting up a committee and in the decision process brought ownership and thus empowerment. The decision to set up a collective farm plot and their required input of labour extended their ownership. The revenues generated empowered the community to consider other improvements. The community effort was also facilitated by the endorsement of the religious leaders. A role-play simulating a public
meeting about water-based, waterborne and water-washed diseases might be considered.

4. **To what extent did the principle that community decision-making needs to integrate ecological, cultural, health, technical and economic dimensions apply to Tonoumassé?**

   - **Ecological dimensions:** limited water resources; climate; biological environment (pathogens); water table and reservoir; soiling of houses and yards.
   - **Cultural dimensions:** roles of women and men; religious practices.
   - **Health dimensions:** recognition of the link between disease and biologically contaminated water and unsanitary conditions.
   - **Technical dimensions:** selection of site yielding water; selection and installation of the pump; pump maintenance.
   - **Economic dimensions:** limited outside help was needed to start the project; a dependable source of revenue was generated through the collective farm plot, permitting pump maintenance and other community projects; low level of water consumption permitted a simple solution.

5. **The ability to respond to community environmental health problems is said to depend on economic prosperity. Was that the only determinant in the pump project?**

   By United Nations standards, Togo’s economic state is weak (a "least developed country"). Economic prosperity was virtually absent. Clearly, teamwork, individual effort, empowerment and motivation are also essential ingredients for solving environmental health problems. The Tonoumassé project illustrates that prosperity must be viewed as a relative parameter. The experience gained also increases the chance of future problem-solving.

6. **How did the pump project make life better in Tonoumassé?**

   - Fewer people get sick and fewer children will die.
   - More children can attend school more regularly.
   - By eliminating the strenuous duties of fetching water, women can grow more food, feed their families better, and sell the surplus to buy other goods.
   - Women’s input is essential in future projects.
   - The villagers have learned to work together and now have the experience to solve other problems and to build a stronger community.
Chapter 6 Questions

1. ■ What criteria were used in selecting the site for the pump?

   Criteria for site selection presumably included: location of the water table; proximity to agricultural land (because of possible drainage and discharge in relation to use of fertilizers, pesticides, manure, etc.); protection of site from other human activities (e.g. industrial activity releasing chemicals to the air; water or soil; garbage disposal); protection from surface drainage and flooding; distance from latrines and toilets.

2. ■ Why is adequate sanitation crucial to a safe local water supply?

   Contamination of drinking-water sources by human waste is the most common source of communicable disease. Any improvement in sanitation services should therefore yield immediate health improvements.

3. ■ Suggest some routine monitoring to test for indicator organisms in the well water.

   The most widely used microbiological indicator is the coliform group of organisms, which has an operational definition. In practice, the coliforms are almost always of intestinal origin, with *Escherichia coli* being the most common. They have life spans that are comparable to those of the pathogenic bacteria *Salmonella* and *Shigella*, and behave similarly during water purification. The maximum acceptable concentration for total coliforms is no organisms detectable per 100 ml. Practical rules for determining compliance take into consideration variation in enumeration because of non-uniform distribution patterns.

4. ■ Outline strategies, other than improving sanitation services, for safeguarding the water supply.

   See answer to Question 1 above.
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


6.2. Role-play: waterborne outbreak in a Romanian town

Prepared by Anca Dumitrescu and Theo de Kok

📅 **Time:** 2 hours

✓ **Objectives:**

At the end of the exercise, students will be able to:

1. Understand the importance of the source of water used for the production of drinking-water.
2. Indicate the multiple causes of a waterborne outbreak of disease and their relative importance.
3. Appreciate the importance of clear legislation with well-defined responsibilities.
4. Appreciate the challenge of achieving consensus on environmental health actions.

📝 **Procedures:**

**Introduction to the case study and role-play (15 minutes)**

1. Introduce the case study of the waterborne outbreak and the role-play exercise using the attached transparencies and written description. Explain that the overall objective of the role-play is to demonstrate and experience the process of decision-making and action planning in order to meet environmental health objectives, which in this case involves safeguarding the distribution of high-quality drinking-water.

2. Divide the class into three groups: the water company, the local authorities (mayor) and the Department of Sanitary Inspection. (Note: If the class is large you may form two groups in each category. Prior to the role-play, allow some extra time for those chosen as representatives of each group to consolidate their position.)

3. Instruct all groups to prepare themselves for a meeting in the city hall where one selected representative will be asked to present the group’s position in a role-play and come to agreement with representatives from the other groups on how to prevent this type of situation from occurring in the future.

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*Dr Anca Dumitrescu, Institute of Hygiene, Public Health Services and Management, Romania
Dr Theo de Kok, Faculty of Natural Sciences, Open University, Heerlen, Netherlands
Preparation for the role-play (30 minutes)

4. The tasks for each group are:
   — to clarify its position;
   — to anticipate and prepare to respond to the positions of the other groups;
   — to prepare a proposal on how to proceed and collaborate in the future in order to meet the needs of one's own interest group, the other groups and the community. (See transparency of guidelines for group work).

5. Visit groups to ensure that they are progressing well in defining their positions.

Meeting at city hall (30 minutes)

6. Invite a representative from each group to play their role in the meeting and negotiate about the solution of the problem. Begin the role-play. (Optional: You may decide to let the rest of the class act as members of the local population who attend the hearing at city hall. If so, allow time for comments and questions from the public.)

Discussion of the role-play (15 minutes)

7. Following the role-play, engage the class in a discussion of:
   — the definition of the key arguments raised and their scientific validity;
   — the underlying causes of the problem (i.e. system of communication among the groups, clear definition of responsibilities, sound attitudes of the key role-players, comprehensive legislation);
   — what can be done to avoid other outbreaks in the future (i.e. financial solutions, legislative improvements, improved interpersonal and communication skills, encouraging teamwork when addressing this kind of problem).

8. Summarize and conclude the exercise.

Materials:

Case description, transparencies, guidelines for small group work, overhead projector, flip chart, coloured markers.
Case description

Waterborne outbreak in a Romanian town

This case study is based on a real outbreak that occurred in a small Romanian town in 1993. The town of “T” is in central Romania and has 9500 inhabitants. “T” is supplied with drinking-water from two sources: groundwater from deep wells of good quality and surface water from the river “S”, which needs treatment. Water from both sources is mixed and chlorinated before distribution.

In 1993, the Department of Sanitary Inspection repeatedly found that the water quality did not meet the standards, that regulations were violated and that the waterworks were poorly managed. The director of the plant had been informed about the health risk related to the distribution of non-disinfected water and penalties were applied several times (see transparency).

The most relevant legislation regarding the drinking-water supply includes:

- the decree on the protection of sources of water used for the production of drinking-water;
- the standard, "Quality of drinking-water", based on the WHO guidelines;
- the national law, "Health of the Population", which states that the Department of Sanitary Inspection is responsible for issuing permits for waterworks and for supervision of producers (the producer is responsible for: the quality of the drinking-water; monitoring of the quality of drinking-water that is distributed; notification of any alteration or malfunctions in the system; maintenance of an appropriate reserve of chloride);
- the law, "Local Authority", which states that the waterworks are supervised by the mayor of the town (see transparency).

The outbreak

A waterborne outbreak started in town “T” on 19 November 1993. There were 101 cases of acute diarrhoea; 8 cases needed treatment in hospital. There were no deaths and the severity of disease was either mild or moderate. From the faeces, Shigella flexneri was isolated.

Prior to the outbreak, on 16 November, the water company stopped the chlorination of the surface water because of a shortage of chlorine. This event was not reported to the Department of Sanitary Inspection or to the local authorities. The first cases of disease were reported by the general practitioners three days after the non-disinfected water began to be distributed.

During the epidemiological inquiry, staff members of the waterworks were not willing to collaborate with the Department of Sanitary Inspection. The director of the waterworks reaffirmed that the town was supplied with groundwater of good quality, which did not need disinfection. The Department of Sanitary Inspection demonstrated that this was false. Based on the analysis of the hardness of the water, it was concluded that mixed water had been distributed instead of just groundwater. Laboratory analysis showed that, although the raw water complied with the standards, the water in the distribution system did not. The latter contained no chlorine and the total number of coliform exceeded the standard.

After the outbreak occurred, the pipe for surface water was sealed and the town was supplied with only groundwater. Other measures that were taken included disinfection of water pipes and storage tanks and the reintroduction of chlorination. The director of the waterworks and the mayor of the town had to pay fines. The public prosecutor was informed and the director was taken to court.
Role-Play
Waterborne outbreak in a Romanian town

Objective

To develop a unified action plan which meets environmental health objectives.
Case Situation

Population:

Romanian town "T": 9500 inhabitants

Sources of water:

- groundwater from deep wells
- surface water from river "S"

Events during 1993:

- repeated violation of sanitary standards
- repeated violation of regulations
- poor management
- repeated penalties
Romanian drinking water legislation

- Decree on protection of sources

- Standard "Quality of drinking-water"
  free chlorine, total chlorine, chemical quality, microbiological safety

- Law "Health of the Population"
  Department of Sanitary Inspection:
    - issues permits
    - supervises the producer

Water company:

- monitors water quality
- reports on changes in water quality
- maintains a reserve of chlorine
Outbreak 19-26 November 1993

Cases:

101 cases of acute diarrhoea
8 cases admitted to hospital
no fatal cases

Water supply prior to the outbreak:
surface water + groundwater

Laboratory analysis:
- raw water O.K.
- water in distribution system contains no chlorine, total + faecal coliform above standard
- faeces of cases: *Shigella flexneri*
Guidelines for small group preparation for meeting in city hall

3 groups:
1. Water company (director)
2. Local authority (mayor)
3. Department of Sanitary Inspection

Task:
1. Briefly summarize the main issues in the situation (i.e. legal, technical, financial) and your conclusions on what caused the problem. Based on this summary, clarify the position of your group.
2. Anticipate and prepare to respond to the positions of the other groups.
3. Prepare a proposal on how to proceed and collaborate in the future in order to meet the needs of your group, the other groups and the community.
4. Select someone to represent your group at the meeting.
6.3. Problem-solving exercise: water availability and trachoma

Prepared by Nancy V. Hicks

ças Time: 3 hours

✓ Objectives:
At the end of the exercise, students will be able to:
1. Utilize knowledge of local customs and lifestyles to design interview instruments.
2. Construct a tabular presentation and calculate percentages using raw data.
3. Identify methods for data collection and interpret tabular data.
4. Draw conclusions from study findings.
5. List intervention strategies for preventing trachoma.

☞ Procedures:
1. This is an unfolding exercise in four parts, designed to mirror the real-life conditions of an environmental health practitioner in the field. Students are asked to analyse the information as it becomes available and to draw conclusions. If all parts of the exercise are distributed at the same time, students should be instructed to work page by page and not to look ahead. Otherwise each part can be distributed separately. The decision to proceed to the next part can be made jointly by the students and instructor. Report-back sessions can take place after each part or at the conclusion of the entire exercise.
2. Introduce the exercise and review its objectives. Divide participants into small groups (4-6 persons). Instruct participants to identify a chairperson and a recorder.
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 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-

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2 Dr. Nancy Hicks, former consultant, WHO
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.

Materials:

Problem-solving exercise (Annex 15), flip chart, coloured markers.

Case scenario, Part I

A major cause of blindness in developing countries is trachoma resulting from repeated infections. Lack of water and increasing distance from the home to the water source has been reported to be associated with the disease, which can be hyperendemic in dusty, dry regions. However, the association is not entirely borne out by the results of all studies.

You are the epidemiologist for a region of 20 villages where the incidence of trachoma is very high. Before promoting increased water supplies as an effective method for preventing trachoma, you decide to investigate the impact of distance to water supply on the prevalence of trachoma and on water use habits among families in your region. You are concerned that factors other than water availability may influence water use for hygiene purposes.

You decide to conduct a risk factor survey for trachoma among a random sample of 20 villages. Interviews (using a pre-tested structured questionnaire) will be conducted by trained local women.

Question 1. Devising items for an epidemiological questionnaire is not always straightforward. For example, you are interested in knowing the time needed to walk one way to a water source. However, in pretesting your questionnaire, you discover that this is difficult to communicate in the interview. How would you creatively deal with this problem in terms of the characteristics of the population that you might be working with?

Knowing the culture of the people to be studied is very important. If the investigator is not wholly familiar with the lifestyle of the population he/she is studying, local residents should be identified to assist in phrasing questions so that they are meaningful and fit within the reference framework of the target population. Anthropologists are frequently skilled in this area. Pretesting the questionnaire for comprehension and revising it as appropriate should be done before it is administered to the study sample.

In this study, the investigators took a unique but practical approach. In order to provide a locally appropriate reference, a series of common household tasks were timed and these were used as examples by the interviewers. For example, “less than 30 minutes” was the time necessary to build a fire and boil water.
Case scenario, Part II

A preliminary summary of your study data indicate that 389 households are located less than 30 minutes from the nearest water supply, 844 are within ½-2 hours, and 705 are more than 2 hours away. In the first group of 389 households, 148 households have no children with trachoma, 97 households have at least one child with trachoma, and in 144 households all children are affected. In the second group of 844 households, 228 have no children with trachoma, 202 households have at least one child with trachoma, and in 414 households all children are affected. In the third group of 705 households, 204 households have no children with trachoma, 148 households have at least one child with trachoma, and in 353 households all children are affected.

Question 2. Presenting study findings in a clear and concise way is very important. Construct a tabular presentation of your data. In addition to absolute numbers of children in each category, include a column with the corresponding percentages.

<table>
<thead>
<tr>
<th>Trachoma status of household (%)*</th>
<th>Time to water source (number of households)</th>
<th>No children affected</th>
<th>Some children Affected</th>
<th>All children affected</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;30 minutes (389)</td>
<td>148 (38)</td>
<td>97 (25)</td>
<td>144 (37)</td>
<td></td>
</tr>
<tr>
<td>0.5-2 hours (844)</td>
<td>228 (27)</td>
<td>202 (24)</td>
<td>414 (49)</td>
<td></td>
</tr>
<tr>
<td>&gt;2 hours (705)</td>
<td>204 (29)</td>
<td>148 (21)</td>
<td>353 (50)</td>
<td></td>
</tr>
</tbody>
</table>

*χ²=2514, P<0.001

Question 3. Now, give an interpretation of your data.

The distance to the water source is associated with the prevalence of trachoma. The proportion of households in which all children had trachoma increased with the time to the source from 37% among those living within 30 minutes, to 49% for those who lived within 0.5-2 hours, to 50% among those living more than 2 hours away.

Concomitantly, the proportion of households in which no children had trachoma decreased as the distance to the water source increased. The proportion of households in which some but not all the children were infected with trachoma also declined as the distance to the source increased.
There appeared to be little difference in the risk of trachoma once the households were more than 30 minutes from the water source.

## Case scenario, Part III

Table 1 below presents the results of logistic regression (a statistical procedure that calculates the association of a particular risk factor with the outcome while controlling for the influence of other variables). (You are now a statistics expert!)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Odds ratio</th>
<th>95 % confidence interval</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Time to water source:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.5-2 hours</td>
<td>1.45</td>
<td>1.08-1.95</td>
</tr>
<tr>
<td>&gt;2 hours</td>
<td>1.37</td>
<td>1.01-1.87</td>
</tr>
<tr>
<td><strong>Quantity of water</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medium</td>
<td>1.01</td>
<td>0.76-1.35</td>
</tr>
<tr>
<td>High</td>
<td>0.84</td>
<td>0.61-1.15</td>
</tr>
<tr>
<td><strong>No. of children</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>2.49</td>
<td>1.93-3.23</td>
</tr>
<tr>
<td>≥3</td>
<td>5.16</td>
<td>3.63-7.37</td>
</tr>
<tr>
<td><strong>Herdng cows</strong></td>
<td>1.85</td>
<td>1.35-2.56</td>
</tr>
<tr>
<td><strong>House with a metal roof (vs. flat or thatched)</strong></td>
<td>0.63</td>
<td>0.47-0.86</td>
</tr>
<tr>
<td><strong>Traditional religion (vs. Christian or Muslim)</strong></td>
<td>1.71</td>
<td>1.28-2.30</td>
</tr>
<tr>
<td><strong>Sleeping next to a cooking fire</strong></td>
<td>1.48</td>
<td>1.14-19.20</td>
</tr>
<tr>
<td><strong>Presence of unclean faces:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>some children</td>
<td>1.30</td>
<td>0.82-2.08</td>
</tr>
<tr>
<td>all children</td>
<td>1.70</td>
<td>1.22-2.35</td>
</tr>
</tbody>
</table>
Question 4. How do you interpret the study results in Table 1?

The risk of trachoma in the household as a fraction of distance to water, irrespective of the amount of water consumed and other confounding factors, was assessed using a logistic regression analysis. Although the students may not have studied logistic regression yet, they know what an odds ratio is.

The results suggest that, although the distance to the water source was associated with an increased risk of trachoma, the risk did not vary with the amount of water brought into the house (odds ratio of 1.01 and 0.84 for medium and large quantities, respectively). Again, the risk was similar for all households that were more than 30 minutes from the water source.

Case scenario, Part IV

Table 2. Distribution of children with clean faces, according to the time (distance) to the water source and the quantity of household water

<table>
<thead>
<tr>
<th>Time to water source:*</th>
<th>N</th>
<th>All clean</th>
<th>Some clean</th>
<th>All not clean</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;30 minutes</td>
<td>386</td>
<td>15</td>
<td>16</td>
<td>70</td>
</tr>
<tr>
<td>0.5-2 hours</td>
<td>831</td>
<td>11</td>
<td>14</td>
<td>75</td>
</tr>
<tr>
<td>&gt;2 hours</td>
<td>691</td>
<td>10</td>
<td>9</td>
<td>81</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Quantity of water</th>
<th>N</th>
<th>All clean</th>
<th>Some clean</th>
<th>All not clean</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>577</td>
<td>10</td>
<td>16</td>
<td>74</td>
</tr>
<tr>
<td>Medium</td>
<td>815</td>
<td>12</td>
<td>12</td>
<td>76</td>
</tr>
<tr>
<td>Low</td>
<td>516</td>
<td>12</td>
<td>10</td>
<td>78</td>
</tr>
</tbody>
</table>

* $\chi^2 = 21.85; P = 0.01$

Question 5. Give an interpretation of the data in Table 2.

The distance travelled to water was itself probably not the determining factor in altering the risk of trachoma, but rather how the water was used within the household. You might, therefore, investigate the relationships between the water variables and the observation of children with clean faces, on the assumption that if either the water source was closer or a greater amount of water was brought into the household, personal hygiene might improve, leading to a decreased risk of trachoma.
The distance to the water source was significantly associated with the presence of children with clean faces in the households. However, the decrease in cleanliness with increasing distance was not large: in 70% of households within 30 minutes of a water source all children had dirty faces, compared with 81% of households that were more than 2 hours away. The relationships between the presence of children with clean faces and the quantity of water brought into the house was even less marked. Essentially, the proportion of households in which all the children had clean faces was the same, regardless of the amount of water that was brought into the house daily.

Data on whether the study children had clean faces were gathered by a subjective appraisal by the interviewers.

Question 6. Comment on the way these data were gathered.

The subjectivity and timing are worrying and could be sources of systematic bias. What one interviewer calls "dirty", another interviewer might judge to be "clean". This leads to misclassification due to interviewer bias. There is no indication of a consistent criterion for what constitutes a "clean" face. Hopefully, if this happened, it would happen equally between both groups and would be non-differential misclassification, with the result of driving the odds ratio towards the null value (decreasing the association if there truly is an association).

Timing is also worrying here. If the interviewer happened to visit the house shortly after the children's faces were washed (whether morning or afternoon), he/she would be likely to record the face as "clean". If, however, the home visit was conducted after the children had been playing for a long while, the interviewer would probably record "dirty". The fact that this was a one-time appraisal, and that there was no consistent criterion to guide the interviewers makes this information less credible.

In addition, children’s faces were less likely to be clean if they were male, aged over 4 years, and if there was another child in the house whose face was also unclean. This clustering of children with unclean faces in households suggests further that hygiene behaviour is governed by family attitudes.

When mothers were asked why their children's faces were not washed more frequently, almost half indicated lack of water as the reason. This response did not, however, vary markedly with the observed cleanliness of the children. This suggests that, although mothers whose children had clean faces may have perceived that lack of water was a constraint to face-washing, in daily practice they did manage to keep their children clean.

Question 7. What are your overall conclusions from this study?

These findings suggest that while access to water may be associated with trachoma, increased risk of the disease is probably not a simple direct function of water availability. And while time is an important factor (mothers who must travel further to obtain water have less time to keep their children clean), the difference in the number of children with clean faces in households located 2
hours or less from water sources compared to households located more than 2 hours from water sources was not large.

**Question 8. How will these study findings influence your opinion concerning increased and closer water supplies as an effective public health intervention for preventing trachoma and blindness?**

Simply providing each village with a functioning water supply may not reduce the prevalence of trachoma in children since the prevalence was not different in villages with and without a constructed water supply. These findings suggest that an important determinant of water use for hygienic purposes is the value placed on the water that is collected. For example, mothers who must travel long distances for water may be less likely to use it for face-washing, regardless of the actual amount of water in the home. Thus, the mother's perception that there is insufficient water for face-washing must be interpreted within the context of the utilization priorities she places on the water available in the home, and not as an absolute pronouncement on the unavailability of water. Even if it were theoretically possible to have a water source within 30 minutes of each home, there is no assurance that water usage patterns would be altered. In fact, results from other studies indicate that, even when a water source is brought closer to home, the amount of water brought into the house does not change dramatically. Classification of mothers' values regarding water usage and their priorities for its allocation should be sought through collaborative efforts between epidemiologists and anthropologists.