International Journal of Environmental Health Research 2, 171–183 (1992)

Environmental health criteria for disaster relief and refugee camps

GARY SHOOK[1]* and A.J. ENGLANDE[2] Jr

[1]*Department of Health Science, California State University, 5500 University Parkway, San Bernardino, CA 92407, USA*
[2]*Department of Environmental Health Science, School of Public Health and Tropical Medicine, Tulane University Medical Center, 1430 Tulane Avenue, New Orleans, LA 70112, USA*

The very subjective nature of most environmental health criteria for disaster relief and refugee camps makes interpretation of minimum quantities of potable water and separation distances from sources of pollution difficult, even for the trained environmental health professional. A review of the literature and a survey carried out with international environmental health professionals were conducted to summarize both the least-preferred and most-preferred parameters for enhanced environmental health services in such camps. The survey was conducted using a form of decision analysis, modified from the Simple Multiattribute Rating Technique. A campsite evaluation form was prepared using the selected criteria, after converting them to utilities. The form was used to evaluate existing refugee camps in Thailand. Camp environmental health scores were then compared to selected environmentally-associated diseases. Results of that evaluation suggest that the environmental health criteria and the camp rating methodology suggested are valid, at least for camps in hot, moist climates.

Keywords: environmental health criteria; disaster relief; refugee camps; potable water

Introduction

When establishing a disaster relief or refugee camp, the location of environmental health services, such as water supply and sewage disposal, is critical. In order to prevent contamination of potable water and to avoid human contact with potential pathogens in human wastes those services must provide minimum quantities or be located at minimum distances from disease sources.

Most literature pertaining to disaster relief and refugee environmental health, although offering to provide guidance on environmental health services at a site, is too subjective for other than the experienced environmental health professional to use in establishing such services. Phrases such as 'adequate drainage', 'suitable soils' and 'away from vector-breeding areas' provide little guidance on numeric values to be met in site planning. The planner, environmental engineer or environmental health professional must rely on his or her professional judgement in interpreting minimum or maximum measurements, such as the minimum separation distance between pit latrines and water wells. The layman, with little or no training in environmental health, has an even greater problem in such interpretations.

The ultimate goal of environmental health services in disaster relief and refugee camps is to promote refugee health by optimizing environmental health services. If providers of

*To whom correspondence should be addressed.

such services are unaware of or cannot determine minimum standards to be met, [illegible] optimization is made difficult and is often impossible.

In an effort to offer both the layman and the environmental health professional [illegible] usable guide to fundamental separation distances and acceptable numeric criteria [illegible] environmental health services of these types of operations, a project was carried out [illegible] identify those parameters and identify a methodology for camp rating based on environmental factors. The project relied on both a review of the current literature and the in[illegible] viewing of international experts in environmental health on their perceptions [illegible] acceptable criteria. The criteria were then tested in existing refugee camps in Thailand [illegible] comparing numeric environmental health site scores against the rates of environmentally associated diseases.

Methodology

The study objective, to summarize acceptable environmental health criteria for disaster relief and refugee camps and to determine a camp rating methodology, has been accomplished by employing the following methods:

1. *Literature search*, to find what environmental health objectives and criteria [illegible] determined at the present time by published authors and reports;
2. *Interview*, to determine criteria and objectives as perceived by experts experienced in the field and who must make decisions relative to selecting refugee camp sites and establishing environmental health services;
3. *Camp survey*, to determine if perceived criteria will, indeed, meet the goal of optimizing refugee health.

The fundamental methodology of this study is decision analysis. Three assumptions are made. First, the process requires professional judgement. Secondly, decisions [illegible] usually made with incomplete knowledge and in a state of uncertainty and third, professionals, given the same information, tend to make the same judgements (Gr[illegible] 1987; Keeney 1988).

Literature search

A literature and file search was conducted in both the United States and in Geneva, Switzerland (Headquarters for the United Nations High Commissioner for Refugees (UNHCR) and the World Health Organization (WHO)) for pertinent papers, books [illegible] reports. Numerous reports exist authored by consultants hired by UNHCR or [illegible] governments that address specific camp locations and environmental problems encountered. Some of these reports recommend criteria to meet specific site constraints. Reports provided by this investigator to UNHCR serve as examples (Shook 1987a, b, 1988a, [illegible]

Both UNHCR and WHO maintain a large library on applicable publications. [illegible] Technical Support Services of UNHCR has a formal library system, administered by [illegible] Information Officer. The World Health Organization has a two-story library, staffed [illegible] several professional librarians.

The interviews

Decision analysis offers a structured method for determining priorities and criteria. It [illegible] often been used in environmental health decision-making (Keeney 1980, Keeney 19[illegible]

Cantor and Knox 1985). To interview international environmental health experts on their perceptions of objectives and criteria for disaster relief and refugee camps, a structured interviewing technique was used. The method for this study is a modification of Edward's decision analytical technique, the Simple Multiattribute Rating Technique (Edwards 1977, von Winterfeldt and Edwards 1987). Seven steps are employed:

Step 1 Identify the person or organization whose objectives are to be maximized. That is, who is the decision-maker? In this research it is the international expert who is requested to assist in establishing a disaster relief or refugee camp.

Step 2 Identify the objectives and issues (decisions) that are relevant. In this case, the issues concern environmental health parameters and the objectives are the specific parameters, such as adequate water supply, sewage disposal and vector control. At this step the interviewed candidates are requested to assure that the list of objectives is complete. They may add or delete objectives. Once they consider the list of objectives to be complete, they are then asked to weight the objectives relative to each other.

Step 3 Identify the attributes to be evaluated. These are the criteria, or measures of the level of achievement of the objectives. In this study an attribute may be a large enough quantity and sufficiently good quality of water to optimize the objective 'Adequate Water Supply'. For instance, how much water, in litres per person per day, should be provided to a camp of nomads in a hot, dry climate? or to a camp of Western-oriented people in a cold, dry climate?

For this step the interviewed candidates are asked to identify that the list of criteria is complete. They may add or delete criteria, at their discretion. Then they are to provide their perception of the least-preferred and the most-preferred value. The least-preferred value is viewed as the borderline between acceptable and unacceptable. The most-preferred value is the minimum or maximum (optimum) criterion a site should meet to optimize environmental health.

For example, 19 litres per person per day in cold, dry climates may be the most-preferred, or optimum, quantity of water all refugees require for good health. However, if circumstances prevailed which would preclude that, the least-preferred, or survival level, might be perceived as 8 litres per person per day. Anything below that value is clearly unacceptable and would result in significant morbidity and mortality.

Step 4 Identify the utilities for the evaluation of the criteria. These are dimensions of value. In this case they are a range, from 0 to 1. The value '0' is represented by the least-preferred criteria and '1' represents the most preferred criteria. For instance, the minimum quantity of water for a general population of refugees in a hot, dry climate is thought to be 9 litres per person per day (lpd). It is assigned a utility value of 0. The optimum quantity, 19 lpd, is noted as 1. If the campsite is found to be capable of producing 14 lpd, then the utility value for water quantity is 0.5. Any quantity below 9 lpd would be scored '0' and any amount over 14 lpd would be assigned '1'.

The individual utility value is then multiplied by a factor related to the number of criteria associated with that objective. The objective 'water quality' could have several criteria: bacteriological quality, heavy metals, inorganic salts, organics. This score is then weighted according to the prioritization given to the objectives in Step 2 of the methodology. In this way, the most important objectives bear more weight than lesser objectives.

Step 5 Measure the utilities $[u(x_i)]$ of Step 4 for each criterion of each objective, where x_i is the objective of interest.

Step 6 Calculate utilities for each objective by summing them $[U = \Sigma\ u(x_i)]$.

Step 7 Determine compliance of environmental health services to the established criteria or decide on corrective action. In this case, the utilities with the highest scores show compliance to environmental health most-preferred criteria. Therefore, those criteria are being met at the site inspected. Similarly, the utility with the lowest value would be the one whose corresponding objective would require the highest priority for correction or show that least-preferred or lesser criteria are met.

Interviews

This portion of the study utilized Steps 1 to 3 of the methodology. To conduct the interview in the manner described above, international environmental health experts were sought. These included UNHCR staff and other international agency personnel and experts who have worked in Water, Sanitation and Health programmes throughout the world and who have first-hand knowledge of the problems encountered in delivery of environmental health services. These professionals have had practical experience with the realisms of service constraints in refugee camps and have been personally involved in setting up such camps.

Criteria for selecting candidates for interviews were established in cooperation with UNHCR's Technical Support Services (TSS) in Geneva. Criteria included length of service, geographical areas served, experience in water supply and other environmental health service operations. The selected experts were given the opportunity to nominate additional interview candidates. In all cases, the candidate was an international environmental health expert in disaster and refugee relief operations.

There was estimated to be 100 international experts who might qualify as candidates. A sampling of 10% of these was considered sufficient. Therefore, the number to be interviewed was kept below fifteen, but every effort was expended in trying to interview at least ten. All potential candidates who could be identified as meeting the criteria were asked to participate.

Formal interviews with selected candidates were conducted by the investigator only, in an attempt to minimize interviewer bias. Initially, the proposed candidates were contacted by telephone. After an introduction, which included the scope and goals of the research, the candidate was asked if he/she wished to participate. If they declined they were asked to name a potential replacement candidate. Every attempt was made to conduct the formal interview in person. For those candidates where that was impractical, the interview was conducted by mail. Candidates were given the opportunity to contact the researcher by phone during the time they were completing the forms.

For those candidates receiving the form by mail, a telephone follow-up occurred one week after the forms were mailed in order to answer any questions. The survey form was reviewed thoroughly with the candidate by the interviewer to assure no misunderstandings or problems in completing the form existed. If the interviewee failed to return the form one week following the completion date, another phone call was initiated or a letter of reminder was sent.

Interview data was tabulated into a microcomputer database. Appropriate statistics of standard deviation and variance were then determined. A summary of all criteria, the least-preferred values and the most-preferred values of each environmental health objective, was then prepared.

Testing

The overall, or end objective, to provide good refugee health by optimizing environmental health at a given site, can be met in two ways: (1) select the best site to begin with; and, (2) provide sufficient environmental services to offset constraints of the site. These can best be assessed by use of a camp survey form. A modified version of such a form was developed to test the validity and accuracy of criteria determined in this study. This utilized Steps 4 and 5 of the methodology and involved the conversion of the criteria to utilities.

It was proposed to test the criteria by way of the camp survey form in at least two refugee operations, using five camps or more selected randomly at each operation area. Camps were to be selected with the assistance of UNHCR's Technical Support Services staff. Due to economic and political constraints, only three camps in Thailand, selected by UNHCR and the United Nations Border Relief Organization (UNBRO), were visited.

Monthly incidence rates of environmentally-associated diseases were acquired from the selected camps. The International Classification of Diseases (ICD) of the WHO (1985) was used, where practical, to provide consistent naming of diseases. The use of incidence rate data from refugee camps constituted secondary data. That is, data collected from sources other than by the investigator (Babbie 1979).

Survey results and incidence rates were entered into a microcomputer database, for statistical analysis. If the sample number, n, was less than ten, Spearman's rank correlation was to be used. If the sample size, n, was ten or greater, simple linear regressions were to be used. In the latter case the hypotheses of similarity between sample populations was to be tested using F-tests.

Analysis and results

Over 1600 publications were reviewed during the literature search. Less than 20 were found to contain guidance, subjective or otherwise, on site planning for environmental health services in disaster relief and refugee operations. Quantitative criteria for environmental health objectives were limited to water supply, sewage disposal and housing. Otherwise only subjective criteria, such as 'provide adequate distances from solid waste disposal sites' or 'assure suitable soils for drainage', were provided. These subjective criteria require professional judgement and are unusable to the layman.

These references also point to the essential repeat of the work by Assar (1971). Although the manual is an extremely important contribution to environmental health in disasters and refugee operations, it is over 20 years old and does not cover a number of pertinent parameters. Terms, phrases and service quantities, as specified in that work, were very frequently re-stated by others in later publications. This was especially true concerning the optimum quantity of water for camps and in the minimum spatial area for camps and housing. Only the minimum quantity of water was new and that was much

Table 1. Summary of Environmental Health Criteria

	Least preferred	*Most preferred*
Water Supply:		
Water quantity, min. lpd, general population		
Cold, dry climate	8.4	18.7
Cold, wet climate	7.9	18.4
Hot, dry climate*	11.8	25.3
Hot, wet climate	9.7	23.4
Water quantity, min. lpd, hospitals		
Cold, dry climate	14.2	27.2
Cold, wet climate	13.6	26.6
Hot, dry climate	18.1	37.8
Hot, wet climate	15.8	30.9
Water quantity, min. lpd, feeding centres		
Cold, dry climate	7.3	15.9
Cold, wet climate	7.0	15.7
Hot, dry climate	11.3	22.0
Hot, wet climate	9.6	18.4
Water bacteriological quality		
Fecal coliform, max. $100ml^{-1}$	31	0
Total coliform, max. $100ml^{-1}$	53	1.8
Fecal streptococcus, max. $100ml^{-1}$	5.5	0
Heterotrophic plate count, max.	1	0
Enterococcus, max. $100ml^{-1}$	20	0
Water chemical and physical quality		
Total dissolved solids, max. $mg\,l^{-1}$	2300	540
Salinity, as chloride, max. $mg\,l^{-1}$	475	412
Nitrates, as Nitrogen, max. $mg\,l^{-1}$	40	10
Fluoride, max. $mg\,l^{-1}$	2.4	2.4
Organics, including pesticides, max. $\mu g\,l^{-1}$	1000	1000
Odour, max.	palatable	none
Taste, max.	palatable	none
Turbidity, max. NTU units	10	5
Colour, max.	-	none
Sewage Disposal:		
Depth of effective soil, min. metres	1.0	2.3
Soil infiltration rate, min. $1m^{-2}$ per day	21	67
Soil type	clay or sand	loam
Depth to groundwater, min. metres	4.1	13.1
Distance to wells, min. metres	41	93
Distance to surface water, min. metres	47	152
Distance to dwellings, min. metres	25	50.3
Solid Waste Disposal:		
Soil infiltration rate, min. $1m^{-2}$ per day	30	61
Soil type	sand	clay or loam
Depth to groundwater, min. metres	8.6	9.8
Frequency of covering, min. days	4.4	1
Depth of soil cover, min. metres	0.4	0.9
Distance to wells, min. metres	28.3	74
Distance to surface water, min. metres	36	144
Distance to dwellings, min. metres	217	366

Table 1. *continued*

	Least preferred	Most preferred
Drainage:		
Slope of entire camp, min. percent	1.6	3.7
Maximum soil infiltration rate, lm^{-2} per day	77	100.2
Minimum soil infiltration rate, lm^{-2} per day	12.5	29.5
Elevation above 10 year flood plain, min. metres	2.5	5.7
Elevation above 100 year flood plain, min. metres	3.5	6.6
Vectors and Pests:		
Distance to mosquito-breeding areas, min. metres	179	632
Distance to fly-breeding areas, min. metres	187	719
Distance to endemic pests, min. metres	310	770
Weather Protection and Housing:		
General camp area, min. smp.		
Cold, dry climate	8.3	16.3
Cold, wet climate	7.5	14.6
Hot, dry climate	6.2	13.1
Hot, wet climate	6.2	12.3
Weather Protection and Housing (continued):		
Dwelling area, min. smp		
Cold, dry climate	2.6	3.8
Cold, wet climate	2.7	4.0
Hot, dry climate	2.7	4.2
Hot, wet climate	2.5	3.5
Hospitals and clinics, min. smp		
Cold, dry climate	3.6	6.4
Cold, wet climate	3.4	6.0
Hot, dry climate	3.1	5.4
Hot, wet climate	3.1	5.6
Meeting and staging area, min. smp		
Cold, dry climate	2.1	3.8
Cold, wet climate	1.9	3.4
Hot, dry climate	1.7	2.8
Hot, wet climate	1.7	3.0
Air and Noise Pollution:		
Distance to noise sources, min. metres	190	359
Distance to natural polluters, min. km	9.6	18.0
Distance to transportation routes, min. km	2.4	3.8
Distance to industrial zones, min. km	1.8	3.9
Site Access:		
Traffic index, min.	1	7.5
Distance to min. standard road, min. km	6.4	0.6
Distance to airport, min. km	33	35
Distance to seaport, min. km	59	54

lm^{-2} = litres per square metre per day
lpd = litres per day
km = kilometres
min = minimum
max = maximum
mgl^{-1} = milligrams per litre
ml = millilitres
μgl^{-1} = micrograms per litre
NTU = nephelometric test units
smp = square metres per person

Table 2. Camp environmental health utility scores* determined in selected Indochinese refugee camps in Thailand

	Ban Vinai	*Ban Napho*	*Site 2*
Water Supply:			
Quantity:			
Gen'l Population	0.056	0.056	0.028
Hospital/clinics	0.056	0.056	0.017
Feeding Centres	0.056	0.056	0.006
Quality:			
Fecal coliform	0.010	0.019	0.000
Odour	0.019	0.019	0.010
Taste	0.019	0.019	0.010
Colour	0.019	0.019	0.000
SUS for water supply	0.224	0.244	0.071
Sewage Disposal:			
Depth of effective soil	0.002	0.028	0.028
Soil type	0.012	0.014	0.028
Groundwater	0.005	0.028	0.000
Wells	0.024	0.003	0.028
Surface water	0.024	0.024	0.024
Dwellings	0.024	0.012	0.000
SUS for sewage disposal	0.091	0.098	0.060
Solid Waste Disposal:			
Soil type	0.014	0.014	0.000
Groundwater	0.000	0.000	0.000
Soil cover frequency	0.000	0.000	0.000
Soil cover depth	0.014	0.014	0.000
Wells	0.014	0.014	0.000
Surface water	0.014	0.014	0.014
Dwellings	0.014	0.014	0.000
SUS for solid waste	0.070	0.063	0.014
Drainage:			
Slope	0.030	0.000	0.000
Max. infiltration	0.030	0.030	0.000
Min. infiltration	0.030	0.030	0.030
10 year flood	0.030	0.030	0.030
SUS for drainage	0.120	0.090	0.060
Vectors and Pests:			
Mosquito breeding	0.000	0.031	0.031
Fly breeding	0.031	0.031	0.031
Endemic pests	0.031	0.031	0.000
SUS for vectors/pests	0.062	0.093	0.062
Weather Protection and Housing:			
Gen'l camp area	0.023	0.023	0.023
Dwelling area	0.021	0.023	0.023
Clinic/hospital area	0.023	0.023	0.023
Meeting place area	0.023	0.023	0.023
SUS for weather protection/housing	0.090	0.092	0.092

Table 2. *continued*

	Ban Vinai	Ban Napho	Site 2
Air and Noise Pollution:			
Noise sources	0.011	0.011	0.011
Natural polluters	0.011	0.011	0.001
Transportation areas	0.011	0.011	0.011
Industrial zones	0.011	0.011	0.011
SUS for air and noise	0.044	0.044	0.034
Camp Access:			
Graded road	0.056	0.056	0.056
Airport	0.000	0.056	0.000
Seaport	0.000	0.000	0.000
SUS for camp access	0.056	0.112	0.056
Total Site Utility Score (SUS)	0.757	0.836	0.449

*Dimensions of value $[u(x_i)]$ for each objective ranging from 0 to 1.

less than that elicited from the interviews (average 5.56 lpd compared to 7.55 lpd).

Although an original objective was to use data derived from the literature in the establishment of the campsite environmental health criteria, such use was found difficult and inappropriate due to a number of factors. These included the lack of applicable literature, the inability to correlate existing literature with data derived from formal interviews, and in the very subjective nature of the literature found by the search. Therefore, literature derived data was dropped from further discussion and analysis.

Table 1 presents a summary of the environmental health criteria determined by the interviews. If only a single value was given for a criterion, that single value was used in all four climatic categories, even though various climatic conditions may occur.

The least-preferred value is interpreted as the borderline between acceptable and unacceptable. The most-preferred value is just that: the preferred minimum or maximum (optimum) criteria a site should meet. Using the quantity of water at a cold, dry site (from Table 1) as an example, 8.4 litres per person per day should be the absolute minimum (least-preferred) amount of water available at the site. However, the most-preferred, or optimum, quantity is 18.7 litres.

A camp survey form was developed in which the environmental health criteria of Table 1 were converted to utilities according to the procedure identified in Step 4 of the methodology. The criteria were rounded off and converted to utility values $[u(x_i)]$. Each category of objectives resulted in a site utility score $[u(x_i)]$. Total site utility scores were determined by adding the individual objective site utility scores $[U = \Sigma\, u(x_i)]$. The form was used in existing camps to test not only the validity and accuracy of the criteria, but also that of the objectives.

Due to financial constraints, only campsite visits to one country were possible. Thailand was selected because of the ease of access and familiarity with the country.

The UNHCR's Technical Support Services in Geneva made a formal request to allow visits to refugee camps in Thailand. The UNHCR representative was requested to permit surveys of three Lao Hillstribes refugee camps in the northeast of Thailand. That agency granted permission to visit only two camps: the Laos Hillstribes camp at Ban Vinai in Loei Province and the Lowland Lao refugee camp at Ban Napho in Nakhon Phanom Province.

The United Nations Border Relief Organization (UNBRO) requested permission to visit at least two Cambodian refugee camps. Permission was granted to visit only one, the camp at Site 2 in Petchenburi Province.

At each site, the appropriate UN Officer was first contacted. The Sanitarian or Environmental Engineer in charge was then met and a camp survey conducted in their presence. Lastly, morbidity data was obtained from the lead medical voluntary agency (Medical Volag).

Site visits were made by the senior author between May 19 and June 2, 1990. Each visit lasted 5 to 7 hours. Camp surveys were conducted using the camp survey form. The summarized data for those surveys are shown in Table 2 and are represented at Site Utility Scores.

The descriptive criteria from the form have been paraphrased in the Table. It is emphasized that these scores represent how well the *existing* camp met the environmental health criteria.

Table 3 summarizes the morbidity data of selected environmentally-associated illnesses from the three study camps. Only hospital and out-patient department (OPD) rates are reported here. Camp medical coordinators considered data from practitioners of traditional medicine or other sources too unreliable and such data was not uniformly available.

The 'average' rates of environmentally-associated morbidity include only those morbidities where data was available from all three camps. Therefore, the rates for intestinal parasites and for accidents and trauma are not included.

Camps visited had low migration due to tight security by Thai authorities. Therefore, rates of morbidities would have been more influenced from conditions and contact from within the camps than from diseases brought in from the outside. Comparison of morbi-

Table 3. Average reported monthly incidence rates of some environmentally-associated morbidities in selected Indochinese refugee camps in Thailand

	Ban Vinai	*Ban Napho*	*Site 2*
Rate per 1000 people:			
Fever (FUO)*	1.0	2.4	5.2
URI†	2.5	1.8	6.3
GID‡	3.8	2.7	6.3
Parasites§	–	–	5.4
Malaria	0.1	0.5	0.7
Skin diseases	1.0	3.2	4.1
Tuberculosis	0.3	0.1	0.4
Accidents and trauma	–	0.1	4.3
Average¶	1.45	1.78	2.42

*Fever of unknown origin; †Upper respiratory infection; ‡Gastrointestinal disease, other than parasites; §Intestinal; ¶Excluding parasites and accidents and trauma: missing data.

Table 4. Apparent relationships established between camp survey scores (SUS) and rates of morbidity for selected Indochinese refugee camps in Thailand

Environmental Health Parameter	*Morbidity*
Water supply	URI, GID, TB*
Sewage disposal	URI, GID, TB*
Solid waste disposal	FUO, GID, Malaria, Skin, Accidents/trauma
Drainage	FUO, GID, Malaria, Skin disease, Accidents/trauma
Vectors/Pests	GID
Weather protection	GID, TB
Air and Noise	FUO, URI, Accidents/trauma
Camp Access	GID
Total SUS	URI, GID, TB

*Unlikely association.

dities with near-by Thai villages was not done since the exercise was to compare environmental conditions within the camps to camp-acquired environmentally-associated diseases.

Because of the small sample size ($n = 3$) use of any comparative statistic was difficult. However, Spearman Rank Correlation Coefficients were determined. Those associations with correlations, r_s, of 1 are shown in Table 4.

Visual inspection of the data shows that Ban Vinai and Ban Napho had the lowest rates of morbidity and were the camps with the best environmental health scores. The data also indicates that the camp with the poorest site scores also corresponds with the camp with the highest overall incidence of environmentally-associated disease. That camp was the Cambodian refugee camp at Site 2.

Discussion

A significant effort was expended in trying to obtain a large number of qualified interview candidates. It was originally estimated that there were at least 100 qualified experts on environmental health with sufficient knowledge of disaster relief or refugee operations. Only 27 candidates were actually identified and requested to participate in the survey. A total of ten completed the interviews.

The number of rejections to be interviewed by international experts was disappointing. Although most cited lack of time or inadequate knowledge in disaster relief and refugee camp environmental health, other reasons may have included a desire not to reveal one's own decision-making process or desire not to reveal one's knowledge of the subject.

Both the number of rejections and the number of no responses emphasize the need to conduct and complete interviews in person, wherever practical. Given the international distribution of the prospective interview candidates, that degree of personal contact regarding this data collection was impractical.

An argument presented to this researcher by an international planning expert against pursuing the research at hand was that this study was only reiterating 'common wisdom'. It is clear from this study that 'common wisdom' as perceived in the literature and that expounded by experts via the interviews is not the same for the environmental health criteria. This is amplified in the lack of specificity offered in the literature search data. That lack emphasizes the need for more complete guidance on the criteria which disaster relief and refugee camps should meet to promote public health.

In the criteria presented in Table 1, it is noted that there is a major discrepancy between the recommended distance to groundwater for sewage disposal and for solid waste, or refuse, disposal. It might be expected that these values would be more similar.

Slope of terrain was not addressed in the survey form or by the criteria as a parameter under Weather Protection and Housing. A maximum slope is probably determinable. This is not only important from the standpoint of dwelling and infrastructure construction, but also from a site accessibility standpoint (Beinin 1979). The island of Pulau Bidong, off the east coast of Malaysia and housing Vietnamese boatpeople, contains over 250 hectares, but only 15 to 20 hectares are suitable for occupation, due to the otherwise steep terrain (Shook 1988a).

When developing the form, it was noted that elimination of the literature search data made little difference in the numeric criteria presented in the final form. The largest difference was seen in the quantity of water recommended. However, the retention of the interview data only favoured more water regarding the minimum quantity (average of 11.1 lpd compared to 9.1 lpd). A somewhat lesser quantity was recommended for the optimum (average of 23.4 lpd compared to 29.0 lpd). The difference was primarily associated with hospital-required water. The interviewed candidates thought that much less than the previous recommendation of 40 to 60 litres per patient was sufficient. The difference in housing space was insignificant (average of 2.75 square metres per person (smp) compared to 2.65 smp).

In the preparation of the camp survey form, criteria for fecal streptococcus, enterococcus and heterotrophic plate count were omitted. This was due to the recommendation of the majority of candidates since these parameters are currently difficult to test for or testing capabilities are not routinely available in remote areas. Both total and fecal coliforms are relatively universally used as pathogen indicators in water supplies and determination is relatively easily accomplished, even at isolated sites. Similarly, testing for chemical and physical water quality parameters has been restricted to only those receiving majority support from the interviewed candidates. The acceptability of a reduction in water quality parameters is generally supported in the literature search. All listed water quality parameters have been retained in Table 1, however, since it may be necessary to include certain metals or trace organics in some site-specific cases where testing capability is available.

Conclusions

Specific, numeric environmental health criteria are needed for the planning and establishment of disaster relief and refugee camps. Current literature provides only subjective criteria such that only experienced environmental health experts can efficiently perform these services. Criteria, as least-preferred and most-preferred values, were determined from international environmental health experts familiar with disaster relief and refugee camp operations. The technique used to elicit and test that criteria was a modification of the Simple Multiattribute Rating Technique. A literature search revealed that pertinent literature specific to disaster relief and refugee camp operation was minimal, limited in scope and generally too subjective for use by laymen. That data was consequently eliminated from the summary of environmental health criteria formulated by this research.

Selected criteria were translated into utilities, used in a camp survey form and tested in existing refugee camps in Thailand. It was found that the camp with the poorest score, that is, least compliance to accepted criteria, also had the highest rates of environmentally-associated diseases. Camps with better scores had lower levels of such diseases.

The criteria have been demonstrated as valid for use in disaster relief and refugee operations located in hot, moist climates. Until contradicted by further use and testing, criteria, as shown herein, are recommended for use by the international disaster relief and refugee service community for evaluation and use. They should be modified only by experienced environmental health professionals, based on individual disaster or refugee camp site conditions.

References

Assar, (1971) *Sanitation in Natural Disasters.* Geneva: World Health Organization, p. 242.

Babbie, E.R. (1979) *The Practice of Social Research.* Belmont: Wadsworth, p. 596.

Beinin, L. (1979) Sanitary consequences of inundations. *Disasters*, 3, 213–6.

Cantor, L.W. and Knox, R.C. (1985) *Groundwater Contamination Control.* Michigan: Lewis Publishers, p. 252.

Edwards, W. (1977) How to use multiattribute utility measurement for social decisionmaking. *IEEE Transactions on Systems, Man, and Cybernetics*, 7, 326–40.

Griffin, R.W. (1987) *Management.* Dallas: Houghton-Mifflin, p. 781.

Keeney, R.L. (1980) *Siting Energy Facilities.* New York: Academic Press, p. 213.

Keeney, R.L. (1988) Structuring objectives for problems of public interest. *Operations Research*, 36, 396–405.

Shook, G.A. (1987a) *Environmental Health Status of Ethiopian Refugee Camps in Somalia, with Recommendations, Six Month Report.* Mogadishu: United Nations High Commissioner for Refugees, p. 10.

Shook, G.A. (1987b) *Environmental Health Status of Ethiopian Refugee Camps in Somalia, with Recommendations, Final Report.* Mogadishu: United Nations High Commissioner for Refugees, p. 12.

Shook, G.A. (1988a) *Engineering Officer's Interim Report on Vietnamese Boat People Camps in Malaysia.* Kuala Lumpur: United Nations High Commissioner for Refugees, p. 21.

Shook, G.A. (1988b) *Engineering Officer's Final Report on Vietnamese Boat People Camps in Malaysia.* Kuala Lumpur: United Nations High Commissioner for Refugees, p. 33.

von Winterfelt, D. and Edwards, W. (1987) *Decision Analysis and Behavioral Research.* Cambridge: Cambridge University Press.

World Health Organization (1985) *International Classification of Disease.* Geneva, WHO, p. 457.