ND SOCIETY

HARISPATTUWA WATER DEVELOPMENT PROGRAMME

ENVIRONMENTAL HYGIENE AND HEALTH FACTORS IN RURAL WATER SUPPLY AND SANITATION PROJECTS

A CASE STUDY IN SRI LANKA

AULI KEINANEN

REPORT·2/83·B

INSTITUTE OF DEVELOPMENT STUDIES
UNIVERSITY OF HELSINKI

COMMISSIONED BY THE MINISTRY FOR FOREIGN AFFAIRS
DEPARTMENT FOR INTERNATIONAL DEVELOPMENT
CO-OPERATION, HELSINKI, FINLAND

WATER AND SOCIETY

HARISPATTUWA WATER DEVELOPMENT PROGRAMME

ENVIRONMENTAL HYGIENE AND HEALTH FACTORS IN RURAL WATER SUPPLY AND SANITATION PROJECTS

A CASE STUDY IN SRI LANKA

AULI KEINANEN

REPORT 2/83 B

INSTITUTE OF DEVELOPMENT STUDIES
UNIVERSITY OF HELSINKI

HELSINKI 1983, ISSN-0539-9493

THIS REPORT IS COMMISSIONED AND FINANCED BY THE MINISTRY FOR FOREIGN AFFAIRS, DEPARTMENT FOR INTERNATIONAL DEVELOPMENT CO-OPERATION, HELSINKI, FINLAND.

... And the Buddha said ... "If one follows the way of the ignorant and does not use a strainer to strain the water he drinks, it would lead to suffering and calamity. Strain the water you drink, for thereby impurities and smaller organisms in the water may not enter your body."

Contents

Acknowledgements

This study was done in close collaboration with the University of Peradeniya, Sri Lanka, the researchers and investigators of which I warmly thank for their co-operation; special thanks is due to our research assistant Mr. H.M. Weerasinghe.

I am also grateful to the employees of the Finnish Water Project (Kandy), the Finnish Embassy (Colombo) and the Sri Lankan organizations for the assistance given by them and especially to the villagers who approved and considered us as members of their community during the time we spent in their village.

I like to thank Dr. Marja-Liisa Swantz from the University of Helsinki (chief co-ordinator of the project) and Dr. Ossi V. Lindqvist from the University of Kuopio, who made it possible for me to participate in this project.

I am also very indebted to Mrs. S.K. Mendis for all advice given during this research and for the critical proofreading of the manuscript of this report.

I am especially thankful to my research colleague Anita Kelles-Viitanen whose friendship and assistance has been irreplaceable in my work and living in Sri Lanka.

I gratefully acknowledge that this study was financed by the Ministry for Foreign Affairs of Finland.

Kandy 28.12.1982

Auli Keinänen

1. INTRODUCTION

This study was carried out to find the relationships between water and the health of people in rural Sri Lanka and the related concepts of the villagers. The study included how people in the village accept the new hand pump wells and especially the quality of the water in them. In addition to this, causes and sources of pollution of water was studied. A satisfactory source of water alone does not guarantee good health. The methods of consumption of water, disposal of excreta etc. are factors which affect environmental health.

This study is a part of a research project "Water and Society" done in co-operation with University of Peradeniya, Sri Lanka, and University of Helsinki, Finland. The research area consists of Harispattuwa Electorate (and small part of Batadumbura Electorate) in Kandy District to which the Finnish government gives development aid in the form of constructing wells and pipelines. Later, with the Finnish aid, material for toilets may be given.

Five villages were chosen for the study from the research area; one of them was chosen for intensive research. This is a village where the Finnish consultancy firm has constructed 10 new hand pump wells.

1.1. The Study Village

The village being studied is in the central part of Harispattuwa. There are 864 inhabitants in the village. The village is considered a typical rural village in the area. Information about population, caste distribution, economic activities etc. is presented in Annex 1.

The village is also a pilot village in shallow well

construction and sanitation plans. During the research also the traditional nature of this village became also prominent - many rituals and old customs, as well as beliefs, were still preserved.

One of the most recent things affecting the way of life of the villagers is television. There are two battery operated televisions now and 116 radios but no electricity as yet in the village.

There are no telephones in the village - the nearest one for public use is 1.5 miles away.

The distance to Kandy is 10 miles. To Kandy and other nearer towns there is a fairly good public transport service.

There are no dispensaries or hospitals in this village. The villagers use hospitals of nearby towns or villages or even go to Kandy General Hospital. There are, however, 6 ayurvedic (traditional) physicians (one of them is registered), one registered midwife and one traditional midwife in the village.

There are two Buddhist temples in the village and one primary and secondary school (Mahavidyale) with 389 pupils and 13 teachers. There is also a post office (opened in 1960) and a grama sevaka's[1] office. A more detailed description of the village is given in the research report of A. Kelles-Viitanen.

---

[1] Government officer in the village.

2. MATERIALS AND METHODS

The study methods used for collecting material and data consisted of participant observation, interviews (formal and informal) and questionnaire for schoolchildren. In addition to this data on the water-related diseases were gathered from registration books of hospitals and the M.O.H.[1] of the area and some water analysis were made in order to get an idea of the quality of drinking and bathing water used in the research area. Photography, too, was used in data collection.

The research time was 5 months (including the writing of the report) which is really too short. I moved to the study village on the 9th of August and stayed there for one month. After that I started to collect data and water samples from hospitals. This, with the water analysis of the village wells took about two months during which time several one or two day trips were made to the research village and also to other villages of the research area.

2.1. Interviews and observations

Participant observation means that the researcher lives among those he studies and participates in their daily lives and tries to learn about their culture. Due to the short time allocated for the research there was not enough time to participate in the daily routines of the villagers. Most of the data were collected by (i) mostly informal interviews at homes while the field investigators were collecting census data from the village and (ii) conducting

---

[1] Medical Officer of Health.

special interviews of health personnel and leading people of the village. The information of the informants and the topics of the discussion are presented in Annex 2, 3 and 4. The information about villagers' concept of good water is mainly from "well interviews" made by A. Kelles-Viitanen, as well as the additional data about the health situation of the village (I participated only in part of these interviews). The description of informants of this interview is presented in the research report of A. Kelles-Viitanen.

The organizations interviewed are shown in Annex 5.

The confidence of villagers as well as making the research more participatory was tried by organizing meetings for the villagers on poya[1] days. In the first meeting the purpose of research and main problems concerning water, health and sanitation were explained; 80 villagers were present. Another meeting was attended by about 100 people. To the third meeting experts of the Finnish Firm were also invited; unfortunately only 15 villagers participated in that one. In the last meeting research results and some advice relating to hygiene were given to villagers (over 100 present) and framed photographs (about village life) donated to the new society building.

2.2. Records of Water-related Diseases

All the available records about water-related diseases in 1981 and 1982 (up to June) have been collected from the research area.

M.O.H. (medical officer of health) keeps records of notifiable diseases like typhoid, dysentery, hepatitis, cholera and poliomyelitis. The information to M.O.H. comes from the hospitals all over the country where they have got patients from this M.O.H. area suffering from some

---

[1] Full moon poya is public holiday in Sri Lanka.

notifiable communicable disease. However, all the hospitals do not keep very accurate records and it seems that all the cases do not reach M.O.H.'s records. Therefore all the available records of possibly water-related diseases have also been collected from the hospitals of the research area.

The morbidity rates of typhoid, hepatitis, worm diseases, abdominal pain and diarrhoea have been gathered from three hospitals (presented in Chapter 3.1.). In one hospital only worms and diarrhoea were recorded and in one only worms and abdominal pains.

These five hospitals where some records were available house indoor patients. The dispensaries that treat outdoor patients also get patients suffering from water-related diseases but because of the large number of patients per day and because of the lack of medical personnel they cannot keep records of their cases.

People of the research area often go to hospitals outside the research area - especially in case of serious disease. These cases are not represented in the records presented in this report. (The notifiable disease cases should be seen in M.O.H. records.)

The statistics presented in this study are really underestimations of the real situation. In addition to lack of records and use of hospitals outside the area there is one more reason for all cases not to be reported here. That is the use of traditional medicine (village physicians) which still covers about 40 % of the medical services used in the area (according to the M.O.H. office of the research area).

2.3. Water Analysis

There are two kinds of diseases related to impure water - infectious water-related diseases and those related to

some chemical properties of water. In developing countries it is the infectious water-related diseases - caused by bacteria, viruses, protozoa and parasitic worms - which are more important. That is why the microbiological quality of water is considered more important in this research. Unfortunately in this study the only possibility to examine the microbiological quality was by coliform bacteria tests. This was mainly due to the lack of equipment for other microbiological analyses. In fact, the research time was also a little too short to even plan this kind of analysis. It is possible to have these types of tests done in other laboratories in Sri Lanka - such as at the University of Peradeniya; although of course a fee would be charged for such services. In further studies it would be important also to analyse other micro-organisms.[1]

The physical factors that have been analysed are colour and turbidity, as this often indicate the quality of water in many other respects, for example the possibility of existence of micro-organisms is higher when turbidity is high.

The chemical elements and compounds analyzed are either those which are directly harmful for the health of human beings (i.e. fluoride and nitrate) or those which could lead to health hazards when present in more than permissible quantities (i.e. chloride, $KMnO_4$ consumption, pH).

Bacterial analyses has been made by using indicator bacteria - total coliform and Escherichia coli - that are not pathogens by themselves but clearly indicate possible faecal pollution. All coliform bacteria are entirely of faecal origin. Therefore the total coliform index can

---

[1] According to Feachem (1978): "In temperate climates water borne diseases are usually bacterial, and the microbiological tests for water quality reflect this tendency, but in hot climates viral, protozoal and metazoal diseases may frequently be water borne; so more consideration must be given to these other micro-organisms."

be quite inappropriate as a measure of direct health hazard, but their presence nevertheless shows poor quality of water. Escherichia coli, on the other hand, are fecal coliform bacteria and indicate a direct health risk. According to World Health Organization[1] for individual or small community supplies water should be condemned if it is repeatedly found to contain more than 10 coliforms or 1 E. coli per 100 ml.

All the water analyses were done in the laboratory of the Finnish Firm by myself and the laboratorist of the Firm. Other possible places for this kind of analyses are mostly in Colombo (i.e. Medical Research Institute, Government Analyst, Environmental Laboratory and laboratory of NWSDB[2]).

Water samples for physical and chemical analyses were taken into clean plastic bottles (volume 1 liter) and for bacterial analyses into sterilized brown glass bottles (volume about 200 ml). The glass bottles were sterilized with ethanol (95 %) - there was no sterilization oven or autoclave in this laboratory.

Total coliform bacteria were always analyzed in the same day of sampling. When the both incubation ovens were in working order, even the E. coli bacteria analyses could be started on the same day. The incubation ovens, anyway, were quite often broken and sometimes the electricity went off during analysing. As a result analysing often took a lot of time and even then all the needed analyses could not be done.

The physical and chemical analyses were usually done during the sampling day and the day after.

Samples that could not be analysed on the same day were stored in the refrigerator.

For physical and chemical analyses the field analyser

---

[1] WHO (1971): International standards for drinking water.

[2] National Water Supply and Drainage Board.

HACH DR-EL/4 was used (includes spectrofotometer and conductivity meter).

Table 1-1. Methods used in physical and chemical analyses

	Method	Range
Colour	APHA Platinum Cobalt Standard Method	0-500 units
Turbidity	Absorptometric Method	0-500 FTU
pH	Electrode Method	0-14 pH units
Carbon Dioxide	Titration Method	0-100 mg/1
Alkalinity	Titration Method	0-250 mg/1
Hardness, total	Titration Method	0-250 mg/1
Acidity	Titration Method	0-250 mg/1
Ammonia	Nessler Method	0-2 mg/1
Nitrite	Diazotization Method	0-0.2 mg/1
Nitrate	Cadmium Reduction Method	0-30 mg/1
Chloride	Mercuric Nitrate Method	0-125 mg/1
Sulfate	Turbidimetric Method	0-150 mg/1
Phosphorous, react.	Ascorbic Acid Method	0-2 mg/1
Fluoride	SPADNS Method	0-2 mg/1
Iron, total	1,10-Phenanthroline Method	0-2 mg/1
Manganese	Periodate Oxidation Method	0-10 mg/1
Bromine	DPD Method	0-4 mg/1
Calcium	Titration Method	0-1000 mg/1
Chromium	1,5-Diphenylcarbohydrazide Method	0-0.5 mg/1
Copper	Bicinchoniate Method	0-3 mg/1
Silica	Heteropoly Blue Method	0-2 mg/1
Conductivity	Direct Measurement Method	0-20.000 mhos/cm

'Total coliform' bacteria analyses were done by using Endo-Agar nutritive agent and incubating for 12 hours at 44°C temperature. For E. coli bacteria the nutrient used was MF-C base and the incubation time was 24 hours at 35°C. Bacteria colonies for 100 ml water were counted.

Samples of water for analysis were taken from:

(i) 10 traditional wells of the research village (12.5 % of all the traditional wells of the village); different kind of wells from different parts of the village were selected for sampling
(ii) all the new hand pump wells of the village (sampling and analysing was done by the Finnish Firm);
analysis of water from the new hand pump wells of other villages have also been presented in this report
(iii) 6 hospitals of research area which have indoor patients;
5 of the hospitals have their own water supply from own wells, one gets its water from the Kandy municipal supply.

From traditional wells only one sample has been analysed. From new hand pump wells first samples were taken from all the wells about one week after construction and chlorination. Sampling was repeated if the first analyses showed too high bacteria and chemical contents in water. If both first and second analyses showed bacteria, the well was chlorinated again and a new analysis done.

Hospital waters were analyzed once chemically and twice bacteriologically. (Although more bacteria analyses were tried the samples were spoilt due to frequent electricity failure.)

All the analysed results have been also given to the Finnish Firm already during the research time.

Results of the analyses are discussed in Chapter 4.

The permission for sampling of water from hospitals has been given by Superintendent of Health Services (Kandy).

2.4. Concepts of Health and Sanitation among Schoolchildren

Two schools, one in traditional Sinhala village and the

other in a small Muslim village in the research area were selected for this study. Children are often less inhibited and more frank and open in their answers, and therefore it was felt that a more real understanding of the existing ideas and situation would be had from a study of this type.

Sixty-two 12-13 year old children studying in the 6th year of their schooling were given a questionnaire in their medium instruction.— Hence the 32 Sinhala children answered the questionnaire in Sinhala while the 30 Muslim children answered in Tamil.

The results of the questionnaire, however, were not totally satisfactory due to problems which were not clearly sorted out in the preparations of the questions, and the translations. Some of the questions were not clear and simple enough to get a satisfactory response from children.

In spite of these shortcomings in the questionnaire, the answers were adequate to get a fair idea of the level of knowledge and the concepts of health and sanitation among the children.

Both the questionnaire and the analysis of the answers are in Annex 6 and 7.

3. WATER-RELATED DISEASES

A water-related disease is one which is in some way related to water or to impurities in water. We can distinguish between infectious water-related diseases and those related to some chemical property of water, as, for instance, cardiovascular disease associated with soft water while high nitrate levels in water are associated with infantile cyanosis. These non-infectious water-related diseases are of major importance only in industrialized countries where infectious diseases have been greatly reduced. In developing countries it is the infectious water-related diseases which are important.[1]

There are five types of infectious diseases that are related to impure water, lack of water or poor sanitation (according to Faechem):

(1) Water borne diseases, such as typhoid, cholera, dysentery, gastro-enteritis (diarrhoea) and where pollution is exceptionally severe infective hepatitis. These are spread by drinking or washing food, utensils, hands or face in contaminated water.

(2) Water washed infections of the skin and eye, such as trachoma, scabies, yaws, leprosy, conjunctivitis, skin sepsis and ulcers. All these are spread by inadequate water for personal washing.

(3) Water based diseases where the vector (carrier) is an invertebrate aquatic organism. The most important are shistosomiasis (or bilharzia, which is transmitted by snails) and the Guinea worm (transmitted by the microscopic crustacean cyclops).

(4) Diseases with water related insect vectors. Mosquitoes (carriers of malaria, filariasis, yellow fever) and blackflies (carriers or river blindness) need water

---

[1] Faechem et al 1978, pp 81-82.

for breeding; some tse tse fly vectors of sleeping sickness usually bite near water.

(5) Infections that are primarily caused because of defective sanitation, such as hookworm.

In Sri Lanka 16 different diseases that can be spread by the ways presented above are identified. They are presented in Table 3-1. According to Sarvodaya (1982) 40 % of the hospital beds in Sri Lanka are occupied by patients suffering from water-related bowel diseases. In 1980 diarrhoeal diseases and helminthiasis were the third highest causes of morbidity in hospitals, following only respiratory diseases and accidents.

Occurance of these diseases is not only related to water and sanitation facilities but also to the nutrition situation.

A combination of malnutrition and infectious disease is the major cause of deaths of children in the Third World. When a child is malnourished, a minor disease like diarrhoea or measles becomes a killer. In Sri Lanka, worm infections are reported to rank third as a cause of infant mortality.[1]

3.1. Occurence of water-related diseases in the whole research area

Numbers of water-related diseases have been collected from those hospitals from the research area where they have records of diseases. These are hospitals that have indoor patients. The outdoor patient dispensaries are not included in this study because they do not keep records of their patients, due to the large numbers of patients who attend these dispensaries per day. Usually dispensaries treat hundreds of patients per day. These patients just get their treatment (medicine) and then go home.

One very important section of the medical system in

---

[1] Agarwal, A., Kimondo, J., Moreno, G. and Tinkler, J. (1981).

Table 3-1. Classification of water-related diseases

Type of disease	Due to water contamination	Due to poor sanitation, lack of health education, inadequacy of water	Due to overcrowding and lack of cleanliness in home, lack of health education	Due to parasitic worms	Due to insect vectors
Typhoid	x	x			
Para-typhoid	x	x			
Cholera	x	x			
Bacillar Dysentery	x	x			
Ameobic Dysentery	x	x			
Infective hepatitis	x	x			
Poliomyelitis	x	x			
Enteritis	x	x			
Hookworm				x	
Whipworm				x	
Thread worm				x	
Round worm				x	
Scabies			x		
Conjunctivities			x		
Malaria					x
Fileria					x

Source: Ministry of Local Government, Housing and Construction, 1980

Sri Lanka is also left out of this study - the traditional medicine (and also home medicine) sector. According to the medical officer of health (M.O.H.) of the research area about 40 % of people use traditional ayurvedic or home medicine.

The records (Tables 3-3...3-8) from the hospitals, presented here could reflect an unreal health situation of the research area. It could be an underestimation - not only because the use of traditional medicine services is not included here but also because many people, especially in case of serious disease, prefer to get treated at bigger hospitals and dispensaries.

The M.O.H. keeps record of notifiable communicable diseases (dysentery, hepatitis, typhoid, cholera, poliomyelitis, tetanus and continuous fever) and is supposed to get the information from every hospital where they get patients from his area, suffering from any of these diseases, even if the hospitals are outside his area.

In hospital records there are, however, lot of diseases that are likely to be water-related but not notifiable and never reach the records of the M.O.H. These diseases are only classified as diarrhoea, worm disease etc.

In this study the (available) disease records of years 1981 and 1982 (up to June) have been collected. The M.O.H. has recorded 79 dysentery, 46 hepatitis, 44 typhoid, 3 tetanus, 1 cholera, 1 poliomyelitis and 1 continuous fever cases for this period (Table 3-2). These figures are discussed more by Dr. Edirisinghe in the socio-economic survey by the University of Peradeniya. In this report the hospital records are emphasized.

Table 3-3. Water-related diseases in selected* hospitals of Harispattuwa in 1981 and 1982 (up to June)

Hospital	No. of persons Typhoid	Hepatitis	Worm diseases	Abdominal pain	Diarrhoea	Total
1. Ankumbura	11	39	89	766	653	1558
2. Medanwala	26	4	20	368	611	1029
2. Katugastota	1	61	31	72	440	611
4. Thittapajjala	-	-	-	-	164**	164
5. Bokkawela	-	-	132	-	249	381
Total	44	104	272	1206	2117	3743

* Hospitals that have inpatients and keep record of diseases

** Includes worm diseases

Table 3-4a. Water-related diseases according to age distribution in Ankumbura Hospital in 1981

Age distribution	Typhoid		Hepatitis		Worm diseases		Abdominal pain		Diarrhoea		Total	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
0-9	0	1	0	1	9	11	32	23	66	54	107	90
10-19	2	1	0	2	5	4	47	47	23	27	77	81
20-29	1	2	3	3	0	1	62	75	23	42	89	123
30-39	0	0	8	1	0	2	30	18	14	20	52	41
40-49	1	1	7	0	0	0	30	22	10	13	48	36
50-59	0	0	0	0	0	0	19	10	11	9	30	19
60-69	0	0	0	0	0	0	16	8	11	5	27	13
70-79	0	0	0	1	0	0	10	4	5	7	15	12
80 and above	0	0	0	0	0	0	3	0	1	2	4	2
Total	4	5	18	8	14	18	249	207	164	179	449	417
Total No. of persons	9		26		32		456+18*		343		844	

* Information about age and sex not given.

Table 3-4b. Water-related diseases according to age distribution in Akumbura Hospital in 1982 (up to June)

Age distribution	Typhoid		Hepatitis		Worm disease		Abdominal pain		Diarrhoea		Total	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Femal	Male	Female
0-9			0	0	16	25			58	55	74	80
10-19			3	0	4	8			18	27	25	35
20-29			1	1	1	4			27	28	29	33
30-39			4	0	1	1			14	20	19	21
40-49			2	0	0	0			17	11	19	11
50-59			2	0	1	0			6	8	9	8
60-69			0	0	0	1			6	3	6	4
70-79			0	0	0	0			7	2	7	2
80 and above			0	0	0	0			3	0	3	0
Total			12	1	23	39			156	154	191	194
Total No. of persons	2*		13		62		292*		310		875	

* Information about age and sex not given.

Table 3-5a. Water-related diseases according to age distribution in Medanwala Hospital in 1981

Age distribution	Typhoid		Hepatitis		Worm diseases		Abdominal pain		Diarrhoea		Total	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
0-9	1	0	0	0	3	2	18	10	52	44	74	56
10-19	6	0	0	0	2	6	27	25	34	15	69	46
20-29	3	0	2	1	2	0	22	20	31	34	60	55
30-39	1	0	0	0	0	2	6	13	16	18	23	33
40-49	0	0	0	0	0	0	7	6	17	14	24	20
50-59	2	0	0	0	0	0	8	9	9	9	19	18
60-69	2	0	0	0	0	1	7	2	8	8	17	11
70-79	3	0	0	0	0	0	8	0	11	5	22	5
80 and above	0	0	0	0	0	0	0	3	7	3	7	6
Total	18	0	2	1	7	11	103	88	185	150	315	250
Total No. of persons	18		3		18		191		355		565	

Table 3-5b. Water-related diseases according to age distribution in Medawala Hospital in 1982 (up to June)

Age distribution	Typhoid		Hepatitis		Worm diseases		Abdominal pain		Diarrhoea		Total	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
0-9	0	0	0	0	0	0	24	14	53	61	78	75
10-19	0	0	0	0	1	0	17	21	18	18	36	39
20-29	1	0	0	0	0	1	16	23	14	19	31	43
30-39	1	0	0	0	0	0	6	10	10	13	17	23
40-49	1	0	0	0	0	0	7	5	7	15	15	20
50-59	1	0	0	0	0	0	6	5	7	14	14	19
60-69	2	0	0	0	0	0	6	6	4	10	12	16
70-79	2	0	0	0	0	0	0	7	6	5	8	12
80 and above	0	0	0	0	0	0	1	1	0	2	1	3
Total	8	0	0	0	1	1	83	92	119	157	212	250
Total No. of persons	8		0		2		175		276		462	

Table 3-6a. Water-related diseases according to age distribution in Katugastota Hospital in 1981

Age distribution	Typhoid		Hepatitis		Worm diseases		Abdominal pain		Diarrhoea		Total	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
0-9	0	0	5	3	1	2	2	2	15	16	23	23
10-19	1	0	3	2	1	2	6	5	10	15	21	24
20-29	0	0	0	0	0	0	9	5	19	20	28	25
30-39	0	0	1	0	0	0	5	4	15	7	21	11
40-49	0	0	0	0	0	0	4	1	8	3	12	4
50-59	0	1	0	0	0	0	4	1	11	4	15	6
60-69	0	0	0	0	0	0	2	1	11	2	13	3
70-79	0	0	0	0	0	1	0	0	5	7	5	8
80 and above	0	0	0	0	0	0	0	0	0	1	0	1
Total	1	1	9	5	2	5	32	19	94	75	138	105
Total No. of persons	2+3*		14+41*		7+4*		51+21*		169+169*		481	

* Information about age and sex not given.

Table 3-6b. Water-related diseases in Katugastota Hospital in 1982 (up to June)

Disease	1st quarter	2nd quarter
1. Typhoid	1	1
2. Hepatitis	1	5
3. Worm diseases	5	15
4. Abdominal pain	0	0
5. Diarrhoea	42	60
Total	49	81

Table 3-7a. Water-related diseases according to age distribution in Bokkawela Hospital in 1981

Age distribution	Worm diseases		Diarrhoea		Total	
	Male	Female	Male	Female	Male	Female
0-9	60	55	29	32	89	87
10-19	5	11	32	44	37	55
20-29	1	0	11	3	12	3
30-39	0	0	3	3	3	3
40-49	0	0	1	1	1	1
50-59	0	0	2	0	2	0
60-69	0	0	2	5	2	5
70-79	0	0	1	0	1	0
80 and above	0	0	0	0	0	0
Total	66	66	81	88	147	154
Total No. of persons	132		169		301	

Table 3-7b. Water-related diseases according to age distribution in Bokkawela Hospital 1982 (up to June)

Age distribution	Diarrhoea	
	Male	Female
0-9	13	19
10-19	14	12
20-29	3	2
30-39	1	2
40-49	1	1
50-59	1	3
60-69	2	1
70-79	2	2
80 and above	0	1
Total	37	43

Table 3-8. Water-related diseases according to age distribution in Tittapajjala Hospital 1981

Age distribution	Worms & abdominal pain		Total No. of persons
	Male	Female	
0-9	28	29	57
10-19	17	23	40
20-29	11	11	22
30-39	8	7	15
40-49	12	4	16
50-59	4	3	7
60-69	5	1	6
70-79	1	0	1
80 and above	0	0	0
Total	86	78	164

Table 3-2. Notified diseases in the research area 1981 and 1982 (up to June) according to M.O.H. of the area

	1981	1982
Dysentery	45	34
Typhoid fever	37	7
Hepatitis	37	9
Tetanus	3	-
Cholera	1	-
Poliomyelitis	1	-
Continuous fever	1	-

Five hospitals in the research area keep records of their cases and are included in this study. One hospital (Fridsro Medical Centre) is not included because of the small number of patients.

The hospitals included in this study are:

(1) Ankumbura district hospital (D.H.) which has two male, one female and one maternity ward with altogether 82 beds and 1 medical officer (M.O.) and one registered medical practitioner (R.M.P.).

(2) Medawala peripheral unit (P.U.) with one male, one female and one maternity ward, 36 beds and two medical officers and one assistant medical practitioner (A.M.P.).

(3) Katugastata peripheral unit (P.U.) which is actually a little outside the research area but commonly used by villagers of this area. This hospital has one male, one female and one maternity ward (40 beds) with one M.O., one A.M.P. and one R.M.P.

(4) Thittapajjala rural hospital and maternity home (R.H./M.H.). It has male, female and maternity wards (27 beds) and one medical officer and one R.M.P.

(5) Boccawela central dispensary and maternity home (C.D./M.H.). There are 12 beds (in the maternity ward) and one R.M.P. in the hospital.

The quality of water has been analysed from all these hospitals (and also Akurana hospital). Results are discussed in Chapter 4.3.

More details of these and all the other hospitals and dispensaries are presented in Annex 8. (The hospitals are located on the map in Annex 9.)

The records of diseases collected from hospitals are for typhoid, hepatitis, worm diseases, abdominal pain and diarrhoea. Only in Ankumbura, Medawala and Katugastota they have records of all these five diseases. From Boccawela only worm disease and diarrhoea cases and from Thittapajjala only worm and abdominal pain cases could be collected.[1]

According to hospital records the total number of water-related cases in the period of 1 1/2 years (1981 and 1982 up to June) is 3743 (Table 3-3). This figure must be at least doubled to get the actual incidence of these diseases of this area (because of the use of other hospitals and traditional medicine).

The diarrhoeal diseases are the biggest problem in all the hospitals, i.e. shigellosis[2] is quite common. Also worm diseases are very usual in the research area.

Children are the hazard group in a discussion of water-related diseases - they have less resistance than adults. The majority of patients are less than 20 years old (Tables 3-4...3-8). In Madawala hospital one child died of diarrhoea in 1981. In Ankumbura 4 people died in 1982 (up to June) due to water-related diseases - three of diarrhoea (1, 10 and 21 years old) and one of worm disease (6 years old).

---

[1] Not only lack of time but also lack of paper in hospitals is a reason for not to keep records. In some hospitals patients are even asked to bring own pieces of paper for medicine prescriptions.

[2] Shigellosis (dysentery) is included in diarrhoeal diseases in hospital records - not classified separately. That is why these always do not reach the M.O.H.'s records.

The most serious cases, however, are usually sent to bigger hospitals (i.e., Kandy General Hospital). So the real death rate might be higher than what can be seen from the records of these hospitals.

The most rainy season in this area is between April and July (south west monsoon). At that time the incidence of diseases is usually highest (Figures 3-1 and 3-2) mostly because the rain water pollutes the drinking water sources and the water is used without boiling. One reason for these diseases is also bathing in open wells and streams. In dry places on the highland of the research area the lack of water can cause diseases. During draught water has to be taken from where ever it is available, irrespective of the source.

Fig. 3-1. Diarrhoea according to monthly occurrance in Ankumbura hospital

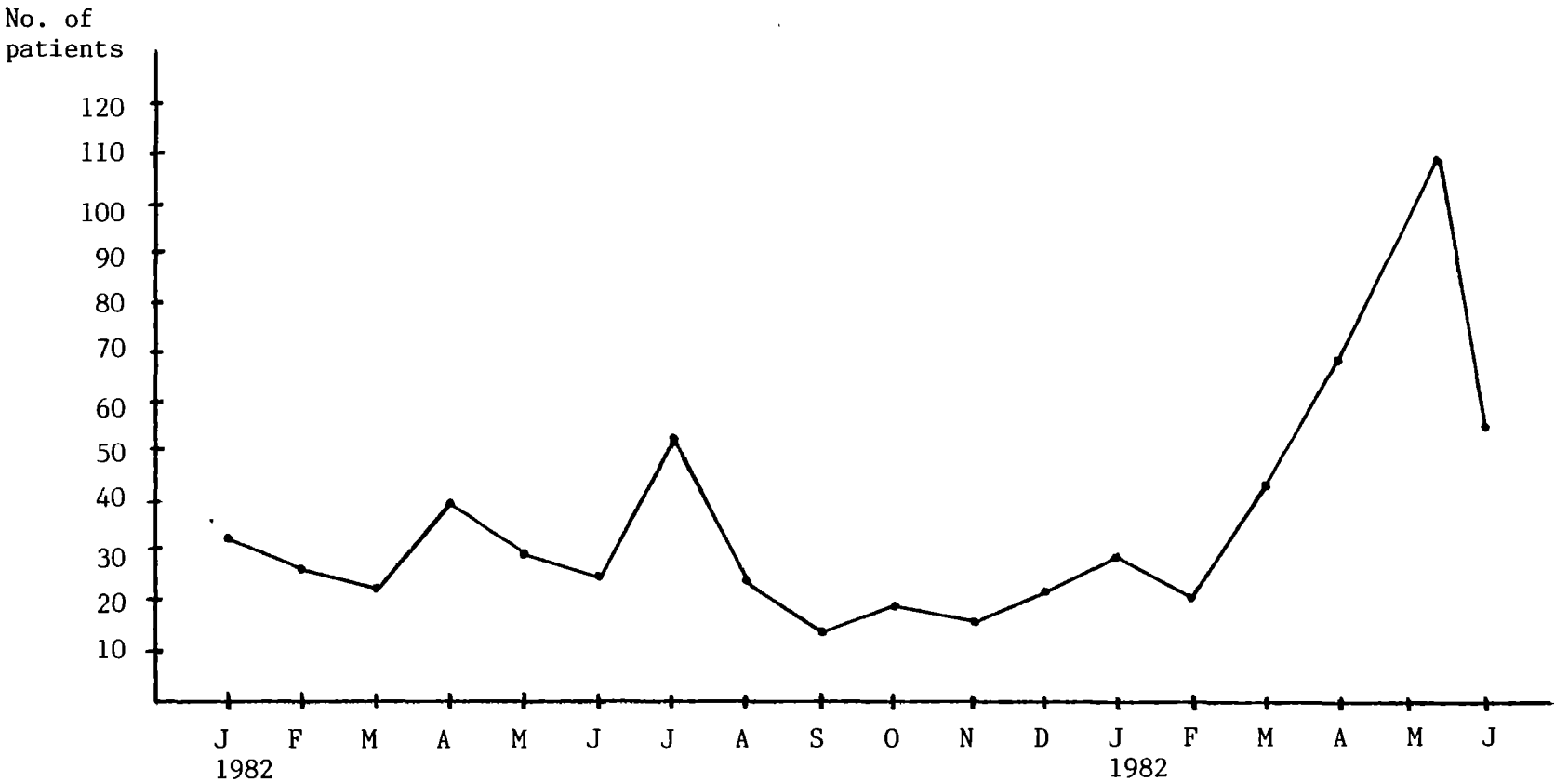
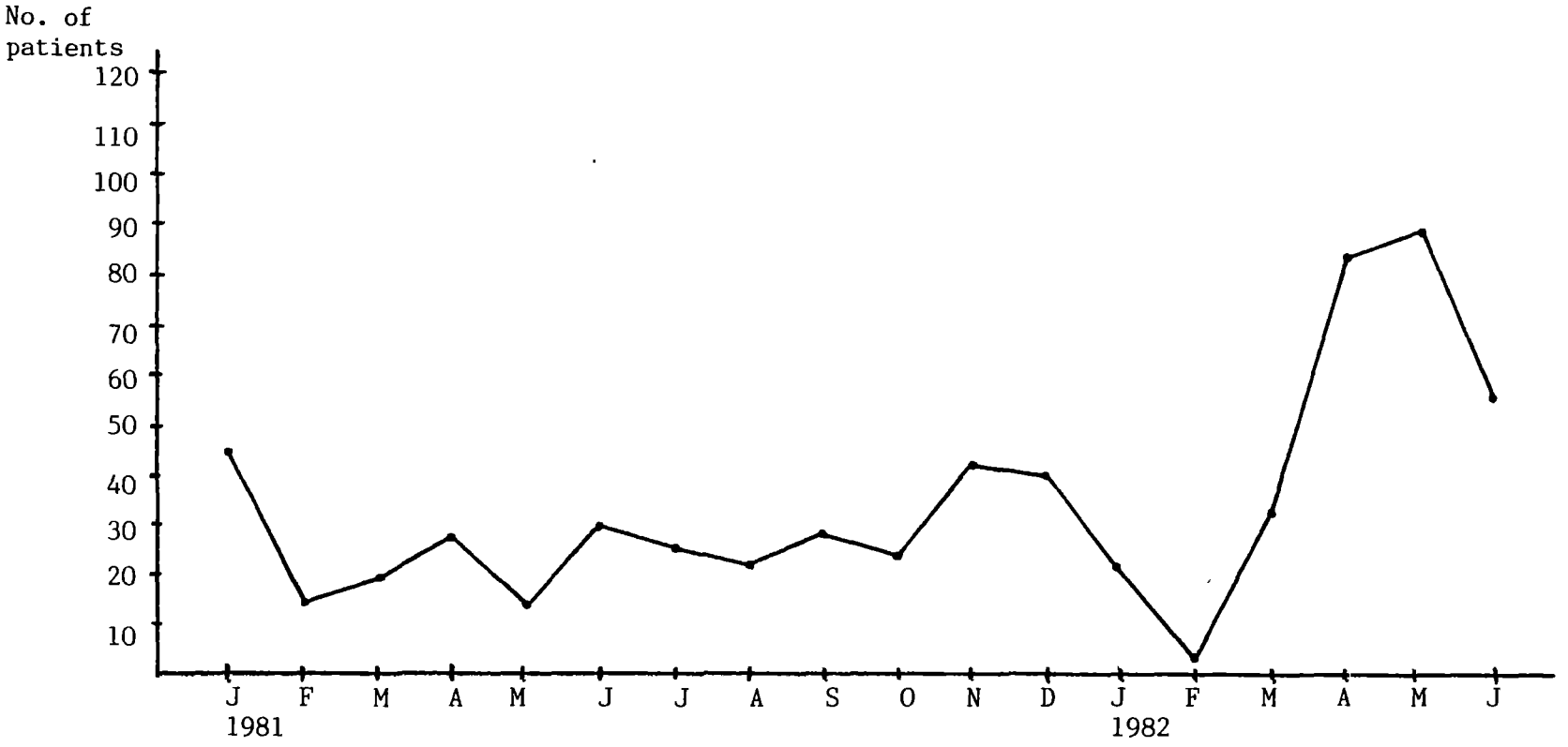


Fig. 3-2. Diarrhoea according to monthly occurrance in Medawala hospital



3.2. Health in Study Village

The health of the study village were worked out by interviewing villagers and health personnel (midwives, nurse, village physician) and village officer (grama sevaka).

According to the villagers the most common diseases are cold, fever and vatte.[1] 15 % of the informants (55 people) said that there has been diarrhoea in the family sometimes, 18 % had had some eye diseases and 20 % some skin disease (usually scabies). It seems that people do not speak very openly about for instance bowel diseases - especially to strangers. So the information gathered by interviewing villagers does not show the real situation.

According to the nurse of the village there was a bacillary dysentery (shigellosis) epidemic in the village one year ago. The cause for this, she said, were the small wells that are situated below the highland into which rain water flows easily and pollutes them. According to her many other diarrhoea epidemics have occurred in the village and one and a half years ago there was hepatitis in three families. Worm diseases are also common in the village. The registered midwife[2] said that the reason for worm diseases are bad drinking water and food and not washing hands properly after toilet and before eating. Typhoid is also said to be quite common in the village.

In 1979 the whole village had scabies (hori) for six months and 1-2 years ago the whole village and the surrounding area had "three days eye disease" ("Tundā Äs Rūdāva).

Out of total of 844 pregnancies in the village 43 (5 %) ended up as stillbirths (this includes the pregnancies

---

[1] Vatte means actually rheumatic pains but it is a general word used by villagers for also many other diseases - sometimes even for diarrhoea.

[2] There are two midwives in the village - one registered and one traditional who has got her education by life experience.

of all the women of the village - also the old ones). So there have been 801 live births; 40 of these children (5 %) died in the first year, 48 (6 %) on the first five years and 12 (1.5 %) after five years old.[1]

Examples of causes of some child deaths are here given by the mothers:

> "One of my children died when she was 5 years old. She had abdominal pain. She had ullogan[2] worms in the stomach; they bit there and went to the heart and bit there also - this caused the death. Blood was coming from nose and mouth."
>
> "My first child died when he was 2 years old. He had mandama.[3] The child was very thin, did not eat and had diarrhoea for one week. The vedahamattaya (ayurvedic physician) gave kasaya[4] but it did not help."
>
> "Four of my children died of mandama when they were 3 years old."
>
> "I have had 11 deliveries; 6 children died. One was a stillbirth. Two died to ullogan and mandama when they were 4 years old; three children lived only for one day."
>
> "One child died of dysentery. At first he got a stomach pain and fever, then diarrhoea. First

---

[1] The information has been collected by field investigators of the University of Peradeniya.

[2] The word ullogan is used by the villagers for some diseases what they think are caused by worms; the actual meaning of ullogan is thrush.

[3] Mandama usually means symptoms of malnutrition and anaemia.

[4] Kasaya is a brew of medicinal plants and is used very commonly for many diseases in Sri Lanka. A brew of coriander and ginger is a simple treatment for the common cold.

we gave wadakaha[1], later we brought him to the hospital where he got drops and tablets. He died after three months."

It is typical among rural Sinhalese people to use traditional (ayurvedic) medicine when a disease breaks out. Ayurvedic medicine is usually made of a variety of medicinal herbs in a variety of ways - brews, pastes, oils, inhalations etc. If the disease gets worse it is common to turn to a Western doctor. It is also a habit that if an illness breaks out at night they get treatment from an ayurvedic doctor (who lives in the village) or use home medicine. At other times they go to hospitals.

Of 40 informants 19 (48 %) said that they use both ayurvedic and Western medicine, 15 (38 %) preferred to use only Western medicine (three of these absolutely rejected traditional medicine). Six people (15 %) preferred traditional medicine (but did not reject Western medicine).

The seven biggest health hazards in the study village are according to one old ayurvedic doctor:

(1) unclean air; especially from toilets
(2) unclean water; when toilet is located at a wrong place or if same well is used for drinking and bathing
(3) when there are many trees in the garden there are lots of mosquitos and worms
(4) small dingy houses are very dirty places
(5) chemicals used in fields create health hazards
(6) wastes are strewn all over
(7) people drink too much toddy[2] and they sometimes mix it with harmful additives.

---

[1] Wadakaha (cinnamon sedge, sweet flag). In Ceylon, an infusion of the rhizome is given for dyspepsia, flatulence, choleraic diarrhoea in children, cough, fever, and with other ingredients for abdominal colic, dropsy, piles, asthma and anaemia. It is antidote for several poisons. (Medicinal Plants Used in Ceylon. Part 1. p. 121).

[2] Toddy is an alcoholic drink usually made of the sap of

He says also that the main reason for diseases is that "food cannot be absorbed by stomach" (diarrhoeal diseases are related to this), the environment is spoiled and that people do not have enough knowledge about sanitation, bathing, eating and clothing and how to use their leisure.

This village doctor classificates diarrhoeal diseases to eight types:

(1) Diarrhoea due to air (in the body)
(2) Diarrhoea due to bile
(3) Diarrhoea due to phlegm
(4) Diarrhoea due to air + bile
(5) Diarrhoea due to bile + phlegm
(6) Diarrhoea due to air + phlegm
(7) Diarrhoea due to blood
(8) Diarrhoea due to indigestion (dyspepsia)

His treatment for diarrhoea is that at first kasaya and tambum is given.[1] If the disease gets worse he gives kasaya. (More about ayurvedic medicine is presented in the socioeconomic survey of the University of Peradeniya by Mr. Karunatissa.)

Usually it is not understood by villagers that poor quality of water can cause diseases. When a person gets e.g. diarrhoea or stomach pain and he realizes that the disease is related to the well water, sometimes the conclusion can be drawn that the well is poisoned[2] (by somebody or something). Some diseases are also caused

---

the inflorescences of kitul palm (Caryota urens). "The root bark and pith of the kitul palm is used for treatment of rheumatic swellings and snake bite poisoning. The inflorescence are tapped for toddy and treacle and jaggery made from it ..." (Medicinal Plants used in Ceylon, Part 4, p. 179).

[1] Tambum is a decoction including garlic, ginger, pepper, black pepper, coriander and thumeric. It can be drank e.g. like a soup.

[2] The beliefs about poisoning of well are discussed by Anita Kelles-Viitanen (1982).

by devils - that is why they are not cured by medicine but by exorcism rituals (by village doctor, astrologist etc.).

4. QUALITY OF WATER

Firstly samples of water from ten of the 80 traditional wells and all ten new hand pump wells of the study village and water used in hospitals, of the research area, with indoor patients, were chemically and microbiologically analysed. Secondly an opinion survey in the selected village was conducted to identify the qualities of good water, accepted by the people.

4.1. The Villagers' Concept of Good Water

During the well interviews conducted by A. Kelles-Viitanen 32 villagers were asked what they considered as "good water". All of them responded with more than one answer and therefore the number of recorded answers is greater than the number interviewed. All those who responded with "good water is clean" were next asked what they meant by "clean water" (Table 4-1).

In the opinion survey appearance, taste and odour were some of the criteria considered in determining whether water is good or bad. 81 % of the informants referred to appearance of water and nearly all of them agreed that good water is colourless - light blue - or silver colour. Clean water in a well often appears to have a tinge of blue due to reflection of the sky.

Because the appearance of water is so important for the people, filtering of water is a very common practice in the village (more about filtering in Chapter 5.1.1.).

While 34 % of the answers indicated that good water has no taste, 16 % indicated that it has no odour.

There have been problems in the village with some of the new hand pump wells because of the iron content

Table 4-1. Villagers' opinions of good water

Good water	No. of informants	% of informants
Clean	12	37
No colour	12	37
Light blue colour	9	28
No taste	8	25
No muddy taste or muddy colour	6	19
The bottom of the well can be seen	5	16
No smell	5	16
Cool	4	13
Heavy	3	9
Running water	3	9
Not salty	3	6
Clear	2	6
White colour	2	6
Not rusty	1	3
Silver colour	1	3
Full well	1	3
Well protected of rainy water and wastes	1	3
Similar to young coconut water	1	3
When water boils there is nothing to be seen	1	3
Filtered and boiled water	1	3
Sweet water	1	3
No answer	2	6

in the water. This water has been described as malakada (rusty) or yakada (ironic) in taste and/or odour. Some people referred to the taste of this water as mada rasa (muddy taste), while others said it was kakkutta rasa (crab taste). The water of these wells has not been used for drinking. Some people say that they cannot use that water even for washing clothes because of the colour and smell.

One informant said that "when good water is boiled there is nothing to be seen" - meaning there are no deposits. This is an important observation with reference to malakada water. When this kind of water is boiled or when it has stayed in a pot for a long time, an oily film like layer forms on the surface of the water (really caused by iron).

When saying that good water is "similar to young coconut water) the informant means that they can drink lots of it, unlike water with an unpleasant taste.

So, good water has no colour, no smell and no taste - this is the belief of the villagers and this is why chlorinated water is sometimes considered a bit strange. It is therefore one reason why villagers never desinfect their own wells (cf. Chapter 5.1.1.) but it is also apparent that they do not understand the purpose of chlorinating because they are ignorant of microbiological pollution of water. They are also economically poor and cannot always afford to buy chemicals used for desinfecting wells.

In one town in the research area people get piped water which is chlorinated. Some people use this water only for washing and take drinking water from wells.

In the questionnaire for schoolchildren 48 % of them remarked that "good water" is clean, and 10 children from the Sinhala school, that is 31 %, mentioned boiled water as good water (Annex 7a).

The reason why well water is not good can of course be due to location and depth of the well - also according to villagers - but this is not all. Bad water in a well is sometimes attributed to many other reasons, such as the choice of an inauspicious time in commencing work or use of the well. To some people it can be even a "family

scourge" not to be blessed with a good well; like one villager said about another (rich) villager: "... he got one well built with his money and 2 masons 15 years ago ... Members of his family cannot build wells. Whenever they attempt to dig a well the water is always dirty ... It was the same with their forefathers. If they built a well the water was always very bad ... They are very rich but they do not have clean water ... and they tried to get drinking water from a new hand pump well ..." (This family lives near the new well that has the highest iron concentration.) The beliefs related to water and wells are discussed further in the report of A. Kelles-Viitanen.

References to microbial pollution of water are notably absent in the popular concepts of "good water". That is because bacteria, viruses etc. cannot be seen, tasted or smelled in the water. It is difficult to understand their existence. This if why boiling of water is neglected so often.

There are many commonly accepted natural phenomena related to the quality of water. Different plant and animal life in and around ponds and wells etc. are considered to be indicators of different qualities of the water in them.

The kumbuk tree (Terminalia glabana) and anthills are considered to indicate the actual presence of water very near them. The kumbuk tree is also associated with clear, cool, good water near it.

The villagers in the research area regard the Potukola (Pan) (Scleria oryzoides) and Batadal as indicators of salty water. Potukola is a tall reed which grows at the edge of paddy fields while the Batadal is a short grass commonly seen, all over the paddy fields.

Certain plants and animals in a well are accepted as purifying agents; whilst some are even introduced to improve the quality of water. Ingini (Strychonos potatorum) is one such nut thrown into wells for clearing the water. These nuts are sometimes rubbed on the inner surface of

clay water pots to precipitate impurities in the water. Diya sevele and Gal sevele are mosses which are encouraged in small amounts and they are also considered good for the water - the popular belief is that they absorb impurities from water. Some kinds of fish (Kanayo), frogs (gembo) and ells (ando) are welcome inhabitants in a well as well. They are considered to eat up smaller plants and animal life and larvae which can make the water impure.

If the frogs and fish in a well die it is certainly an indicator of "poison" in the water, and the users of the well are cautious and take notice of such "warnings".

A few people, however, are somewhat cynical towards such a simple logic and would rather have their wells free of all forms of plant and animal life.

4.2. Quality of Water in Wells of the Village

Samples of water have been taken from 10 traditional wells (12.5 % of all the traditional wells) and from all the 10 new hand pump wells of the research village.

4.2.1. Traditional Wells and Other Water Sources

There are 80 traditional water sources in the village. They can be divided into 6 types (according to A. Kelles-Viitanen):

(1) mud hole wells
(2) stone wells
(3) pihillas (spouts)
(4) tree trunk wells
(5) tyre wells
(6) cement wells

The structure and number of each types are described in the reseach report of A. Kelles-Viitanen.

Except trunk wells[1] all other types of wells are represented in the analyzed wells (Table 4-2).

Table 4-2. Analysed wells according to the type, use of the well and number of users

Well no.	Type	Use of well drinking/ bathing	Number of users	
			Families	Persons
6	pihilla	d, b	15	~50...60
9	cement well	b	20	~200
10	cement well	d	15	~100
33	mud hole	d	10	~50
39	stone well	d, b	2	14
41	cement well	d	25...30	190
53	cement well	b	30	-
56	tree trunk well	d	25	-
63	pihilla	d, b	20	-
64	cement well	d	14	>100*

* Also one shop using.

Water samples were taken from different parts of the village both from drinking and bathing wells (Table 4-2, Figures 4-2...4-19 and 4-12).

[1] Only 2 of the 80 traditional wells are trunk wells.

Fig. 4-2. Drinking and bathing pihilla (drinking water from tank, bathing under pipe) used by 15 families (No. 6)

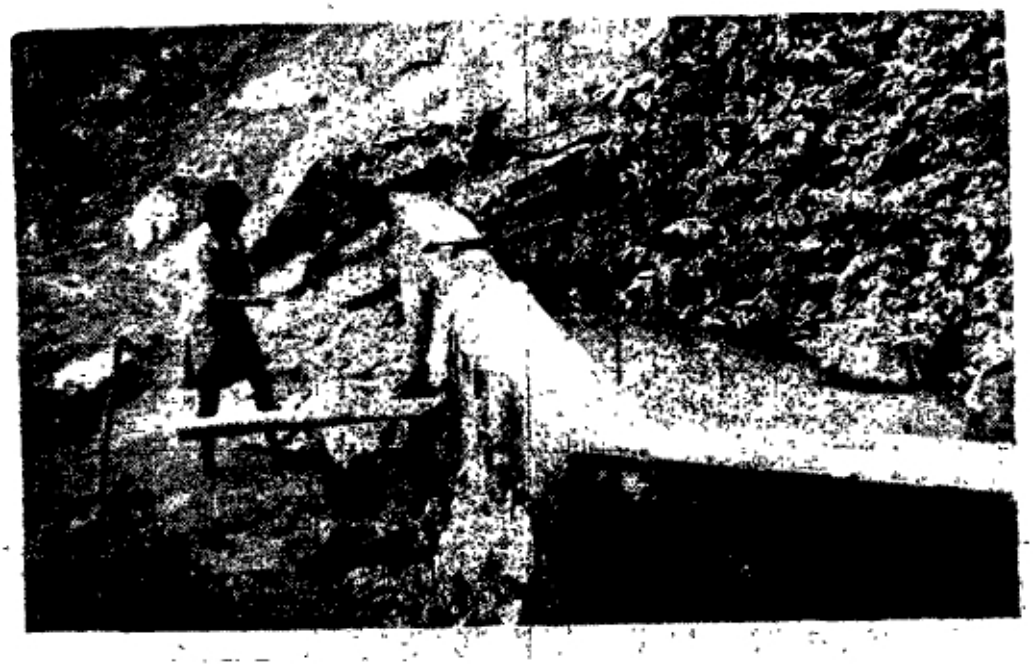


Fig. 4-3. Cement well for bathing (same well as in Fig. 5-2) used by 20 families (No. 9)

Fig. 4-4. Cement well for drinking in the middle of a paddy field, used by 15 families, about 1 meter deep (No. 10)

Fig. 4-5. Mud hole for drinking purposes in the middle of a paddy field, used by 10 families, about 2 meters deep (No. 33)

Fig. 4-6. Stone well used for drinking and bathing by 2 families (No. 39)

Fig. 4-7. Small cement drinking well for 25...30 families (No. 41)

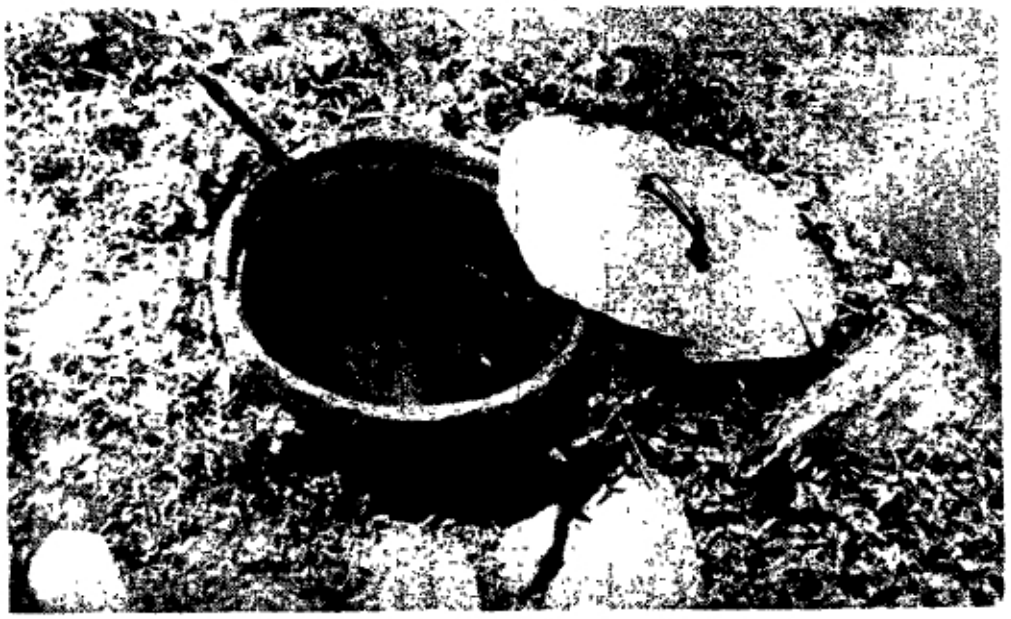
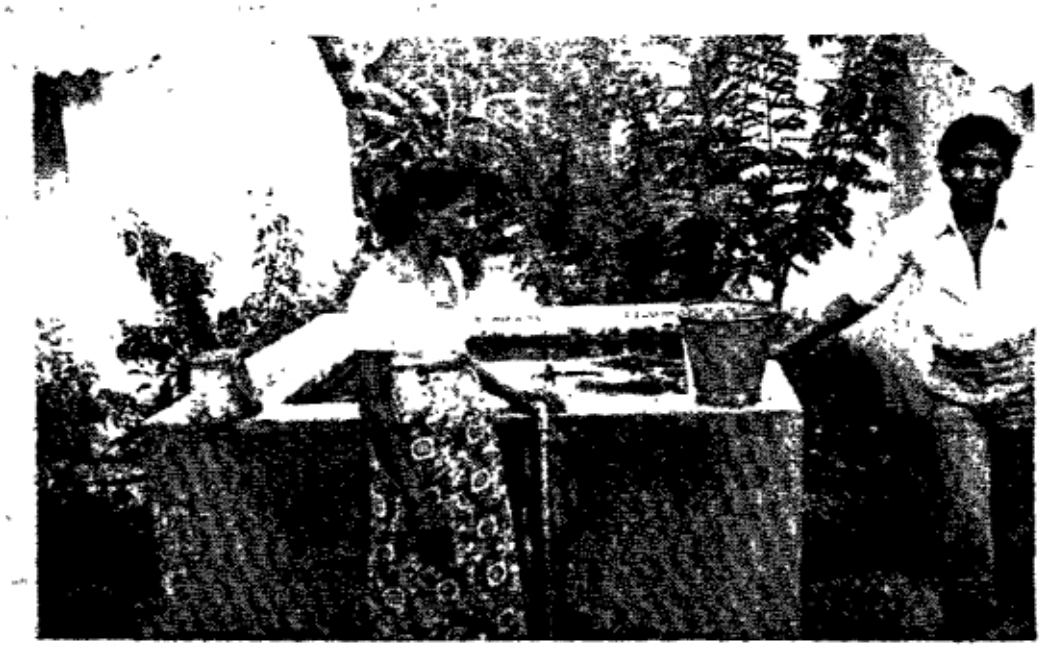


Fig. 4-8. Cement bathing well used by 30 families, 2 meters deep (No. 53)

Fig. 4-9. Kitul tree trunk well in the paddy field used for drinking by 25 families, 1.4 meters deep (No. 56)*

* Nearby is a new hand pump well that is abadoned due to its rusty water.

Fig. 4-10. Tank used mainly for drinking purposes by 20 families (housing scheme), water coming through pipe from mountain (No. 64)



The analysis of the quality of water in traditional wells is shown in Table 4-3.

The chemical quality in these wells is quite satisfactory. However the iron concentration in some wells is slightly higher than accepted due to the iron content in soil. Colour and turbidity rates are also rather high in some wells (especially in the bathing well No. 9). This shows poor quality of water in many respects, e.g. existence of micro-organisms is more probable when turbidity is high. High colour and turbidity rates can be due to suspended clay, silt and fine organic and inorganic matter.

One of the wells has a very high $KMnO_4$ consumption rate. This generally indicates the presence of organic matter in the water although at times it can be due to the presence of iron.

Bacterial quality in all these wells is poor. The presence of coliform bacteria clearly indicates faecal pollution of water. There can be several reasons for this

Table 4-3. Water quality in traditional wells in the study village (sampling date 19.10. 1982, except numbers 31 and 56(I) which are sampled 2.8.1982)

	Drinking well no.										Bathing well no.	
	06	10	31	33	39	41	56(I)	56(II)	63	64	09	53
Colour mg/l Pi	10	20	nil	50	20	nil	nil	10	25	25	240	30
Turbidity Ftu	3	5	nil	13	3	nil	nil	nil	5	5	65	7
pH	6.29	5.83	6.00	5.86	5.80	5.53	5.63	5.27	5.80	5.83	6.08	5.72
Carbon dioxide mg/l CO_2	8	12	-	8	9	13	-	20	10	10	9.5	18
Alkalinity, total mg/l $CaCo_3$	46	29	-	37	51	nil	-	15	35	36	25	46
Alkalinity, phenolphtalene mg/l $CaCo_3$	nil	nil	-	nil	nil	34	-	nil	nil	nil	nil	nil
Hardness, total mg/l $CaCo_3$	93	16	-	39	44	24	-	9	37	40	18	42
Ammonium mg /l NH_4	0.04	0.02	0.024	0.07	0.04	nil	0.061	0.02	0.05	0.04	0.41	0.05
Nitrite mg/l NO_2	0.017	0.013	0.043	0.023	0.026	0.020	0.04	0.023	0.020	0.026	nil	0.026
Nitrate mg/l NO_3	3.1	2.2	-	2.2	3.5	3.1	-	2.2	3.1	2.6	nil	3.82
Chloride mg/l Cl	7	6	-	nil	6	6	-	4	5	6	13	18
Sulphate mg/l SO_4	3	4	-	30	33	57	-	2	2	5	nil	6
Phosphorous, reactive mg/l PO_4	0.30	0.23	-	0.26	0.24	0.33	-	0.35	0.15	0.10	0.15	0.17
Iron, total mg/l Fe	0.05	0.30	0.09	0.48	0.10	0.03	0.09	0.03	0.13	0.12	1.20	0.45
Manganese mg/l Mn	nil	nil	nil	nil	nil	nil	nil	0.1	nil	nil	nil	nil
Bromine mg/l Br	0.03	0.06	-	nil	0.05	nil	-	nil	0.02	nil	0.10	nil
Calcium mg/l $CaCo_3$	28	11	-	17	23	12	-	5	24	30	11	25
Chromium mg/l Cr	0.010	0.015	-	0.010	0.018	0.018	-	0.020	0.015	0.018	0.003	0.013
Copper mg/l Cu	0.03	0.05	-	0.05	0.05	0.03	-	0.03	0.04	0.05	0.06	0.05
Silica mg/l Si	9.00	9.00	-	8.75	9.00	8.75	-	9.00	9.00	9.00	8.75	8.50
Conductivity at 25°C µs/cm	134	82	114	138	140	90	53	62	103	107	93	168
$KMnO_4$ consumption mg/l	4.9	7.9	14	5.9	3.9	6.9	24	4.9	5.9	5.9	51.3	6.9
Bacteria:												
Total coliform 35°C /100 ml	plenty	13	9	5	5	plenty	nil	plenty	8	plenty	plenty*	plenty
E. coli 44°C /100 ml	5	8	nil	1	1	8	nil	3	nil	20	nil	plenty

* Not clear coli.

kind of bacteria contamination. It nevertheless shows a poor level of environmental hygiene. This topic is discussed further in Chapter 6.

4.2.2. New Hand Pump Wells

There are 10 new shallow hand pump wells (depth 3...9 meters) in the village. Samples of water have been taken from all of them.

The hand pump wells of the village are almost the first wells constructed by the Finnish Project in Sri Lanka. There have been some problems related to the quality of water of these wells.

The biggest problem with these wells has been the high iron concentration (Table 4-4). The highest analysed iron concentration has been 8.9 mg/l when highest allowable amount is 1 mg/l (according to international standards, see Annex 14). Certain layers of soil have a higher iron content. So the iron concentration in water can be due to the depth of the well. In traditional wells that are not as deep as the new wells the iron content is much lower.

Iron gives colour and taste to water even in quite small amounts. That is why villagers immediately abandon this kind of well or use it only for washing feet and hands or clothes. Sometimes the rusty colour and smell is so great that the water cannot even be used for washing clothes. In some wells iron has coloured the slab of the well reddish.

Obviously due to the existence of iron the $KMnO_4$ consumption is also quite high in these waters (Table 4-4).

The ammonium content, too, in the water of the new wells seems to be higher than in traditional wells. Ammonium compounds form in the water when nitrogen compounds are decomposed. Hence, the presence of ammonium ions could be an indication of human or animal waste pollution of the water. Ammonium compounds can also come from fertilizers or even from ammonium salts of the soil. The last mentioned

Table 4-4. Water quality in new hand pump wells in the study village

Well No.	8	10	12		13	14			15		16	20	21			22
Sampling date	6.7 82	6.7 82	6 7.82	2.8.82	6.7.82	13.7.82	2.8.82	6.7 82	20.9.82	6.10 82	6.7.82	6 7.82	6.7.82	13.7.82	2.8 82	6.7.82
Appearance *	1;2	1,2	3;4	-	5,4	;	-	1,2	-	7,6	1;2	1;2	1,2	-	-	1,2
Odour	nil	nil	nil	-	nil	nil	-	nil	-	nil	nil	nil	nil	-	-	nil
Colour mg/l Pt	4	50	145	70	110	90	150	3	-	220	20	50	25	-	-	10
Turbidity FTU	2	13	38	18	30	30	40	2	-	60	7	10	7	-	-	2
pH	-	-	-	6 58	-	-	6 75	-	-	6 09	-	-	-	-	-	-
Carbon dioxide mg/l CO_2	20	21 5	21	-	18	28		6 5	-	0 9	16	17 5	14.5	-	-	18.5
Alkalinity, total mg/l $CaCO_3$	116	154	127	-	151	126	-	37	-	34	190	152	59	-	-	148
- phenotalene mg/l $CaCO_3$	nil	nil	nil	-	nil	nil	-	nil	-	nil	nil	nil	nil	-	-	nil
Hardness, total mg/l $CaCO_3$	106	153	141	-	148	115	-	39	-	44	199	150	76	-	-	147
Acidity, free mg/l $CaCO_3$	nil	nil	nil	-	nil	nil	-	nil	-	nil	nil	nil	nil	-	-	nil
- total mg/l $CaCO_3$	nil	nil	nil	-	nil	5	-	nil	-	5	nil	nil	nil	-	-	nil
Ammonium mg/l NH_4	0 34	0 31	0 93	0.65	0 59	1 67	1 65	0 22	-	0.695	0.33	0 48	0.45	0 48	-	0 22
Nitrite mg/l NO_2	0 05	0.063	0.036	0.023	0 033	0 264	0 026	0 059	-	0 007	0.043	0.059	0.21	0 211	-	0 05
Nitrate mg/l NO_3	2.64	1.76	0.88	-	1.32	2.2	-	3.96	-	4.84	1.76	1.76	10.12	-	-	2.64
Chloride mg/l Cl	1	nil	nil	-	9	5	-	4	-	10	18	nil	18	-	-	10
Sulphate mg/l SO_4	nil	nil	nil	-	nil	nil	-	nil	-	2.5	2	nil	nil	-	-	nil
Phosphorous, reactive mg/l PO_4	0.24	0.13	0 12	-	0.14	0.18	-	0.19	-	0.09	0.14	0.13	0.24	-	-	0.19
Fluoride mg/l F	0.39	0.32	0.27	-	0.32	0.19	-	0.33	-	-	0.29	0.35	0.24	-	-	0.38
Iron, total mg/l Fe	0 14	0.95	0.27	1.4	1.9	8.9	4.0	0.09	-	0.99	0.28	1.1	0.2	-	-	0.3
Manganese mg/l Mg	0.9	0.9	0.7	0.6	1.8	1.6	1.3	nil		nil	0.7	1.4	0.2			0 2
Bromine mg/l Br	0.02	nil	0.03	-	nil	0.1	-	nil	-	0.05	0.02	nil	0.02	-	-	nil
Calcium mg/l $CaCO_3$	93	133	121	-	120	89	-	23	-	25	163	124	57	-	-	140
Chromium mg/l Cr^{6+}	0.015	0.01	0.007	-	nil	0 008	-	0 018	-	0.018	0.015	0.01	0.015	-	-	0.016
Copper mg/l Cu	0 05	0.04	0.08	-	0.05	0.32	-	0.04	-	0.05	0.08	0.05	0.05	-	-	0 06
Silica mg/l SiO_2	39	33	25	-	38	34.5	-	11	-	25	26	27	14	-	-	34
Conductivity at 25° µs/cm	230	300	290	290	300	350	360	120	-	132	430	320	240	-	-	350
Oxygen, dissolved mg/l O	0.25	0.27	0.22	-	0.19	0.6	-	0 31	-	4.3	0.3	0.21	0.29	-	-	0 29
$KMnO_4$ consumption mg/l	11	14	18	20	18	30	21	20	-	27	18	16	17	-	-	17
Sodium chromate mg/l Na_2CrO_4	5	25	40	-	45	30	-	nil	-	125	15	20	10	-	-	nil
Bacteria									-					-	-	
Total coliform 35°C/100 ml	nil	nil	1	-	nil	30	-	plenty	9	16*	3	nil	plenty	plenty	39	plenty
E coli 44°C/100 ml	nil	nil	nil	-	nil	nil	-	plenty	4	29	nil	nil	plenty	plenty	plenty	60

* colourless = 1, clear = 2, sl. yellow = 3; sl turbid = 4; light yellow = 5, light turbid = 6; yellow = 7; turbid = 8

possibility might be the most obvious in this case because in traditional open wells the ammonium concentration is much lower.

Fig. 4-11. New hand pump well that is now used only for washing purposes because of its rusty water

Fig. 4-12. Traditional well near the hand pump well (Fig. 4-10) used by 15 families; well is covered at nights; water quality good (No. 31)

All the new wells have been chlorinated before taking into use and the water analysed after one week of chlorination. If and when the analyses revealed any unsatisfactory characteristics, new samples were analysed.

In some wells there have been surprising high coli bacteria contents (Table 4-4). In one well the bacteria seem to have disappeared after repeated chlorination, but in another well bacteria continued to be present even after additional chlorination. In fact the quality of water on one count became more unsatisfactory after secondary

desinfection. The rainy season could also have affected the quality of water if the joints in the well were not sealed adequately.

Because of the unsatisfactory characteristics of the quality of water only 5 of the 10 new hand pump wells are now used for drinking purposes. This is mainly due to the iron content in the water. The Finnish Firm now plans to introduce remediae treatment systems to those "iron wells". Some wells have been abandoned (or used only for washing purposes) temporarily after chlorination because of the taste of chlorin.

Fig. 4-13. Chlorination of hand pump well by the local workers of the Finnish Firm (waiting for the effect of chlorin)

For comparison also the analysis results of the new hand pump wells of other villages in the research area are presented here (Table 4-5).

It seems that the problem with the quality of water exists not only in the new wells of the research village. Ten of thirty wells analysed in other villages had iron

Table 4-5. Water quality in new hand pump wells in other villages (autumn 1982)

Well No.	1	4	5	6	7	7	9	11	11	17	17	18	19	23	24	25
Sampling date	20/9	20/9	2/8	2/8	6/7	2/8	13/7	2/8	20/9	20/9	6/10	20/9	20/9	13/7	13/7	20/9
Colour mg/l Pt	60	10	5	125	>500	320	240	75	-	nil	10	15	75	5	nil	nil
Turbidity FTU	18	2	5	30	175	85	63	20	-	nil	3	2	20	2	nil	nil
pH	6.51	7.08	6.80	6.77	-	6.83	-	6.74	-	6.76	6.56	6.65	6.77	-	-	6.75
Carbon dioxide mg/l CO_2	19.0	8.5	1.7	1.4	24.5	-	24.0	1.2	-	12.1	1 0	18.0	18.5	23.0	16.0	9.5
Alkalinity, total mg/l $CaCO_3$	103	120	88	80	193	-	105	75	-	79	70	118	156	94	69	81
- phenolphthalene mg/l $CaCO_3$	nil	nil	nil	nil	nil	-	nil	nil	-	nil	nil	nil	nil	nil	nil	nil
Hardness, total mg/l $CaCO_3$	105	152	96	80	169	-	95	84	-	90	81	125	171	106	77	95
Acidity, free mg/l $CaCO_3$	nil	nil	nil	nil	nil	-	nil	nil	-	nil	nil	nil	nil	nil	nil	nil
- total mg/l $CaCO_3$	nil	nil	nil	nil	nil	-	nil	nil	-	nil	nil	nil	nil	nil	nil	nil
Ammonium mg/l NH_4	0.19	nil	0 04	0.63	>2	7 32	1.50	0.79	-	0.11	0 18	0 18	1.65	0.13	0.05	0 05
Nitrite mg/l NO_2	0.003	0.003	0.05	0.026	0.033	0.033	nil	0.043	-	0.129	0 003	0.013	0.066	0.063	0.053	0.040
Nitrate mg/l NO_3	2.20	3.52	1.54	1.76	3 52	-	0.44	2.20	-	3 30	2.20	3.52	3.52	2.20	2.64	4.40
Chloride mg/l Cl	4	11	7	6	10	-	3	6	-	3	5	9	7	4	5	7
Sulphide, hydrogen mg/l H_2S	-	-	-	-	nil	-	-	-	-	-	-	-	-	-	-	-
Sulphate mg/l SO_4	nil	nil	nil	nil	nil	-	nil	1	-	4	4	3.5	1.5	nil	nil	nil
Phosphorus, reactive mg/l PO_4	0.1	0.08	0.23	0.15	0.14	-	0.18	0.14	-	0.09	.015	0.2	0.07	0.18	0.17	0.08
- acid hydrolyzable mg/l PO_4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
- total mg/l PO_4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fluoride mg/l F	0.32	0.18	0.12	0.15	0.25	-	0.2	0.2	-	0.40	-	0.25	0.32	0.23	0.18	0.25
Iron, total mg/l Fe	1.30	0.05	0.35	2.00	2.40	8.00	9.50	1.60	-	0.29	0.30	0.35	0.89	0.19	0.03	0.08
Manganese mg/l Mn	0.25	0.10	0.10	0.20	2.40	2.25	1.40	2.40	-	0.80	0.95	0.86	2.50	0.40	0.20	nil
Bromine mg/l Br	0.05	nil	0.1	nil	0.1	-	0.1	nil	-	0.03	0.01	nil	0.04	nil	nil	nil
Calcium mg/l $CaCO_3$	83	112	79	55	151	-	74	60	-	67	59	97	142	69	54	84
Chromium mg/l Cr	0.022	0.01	0.015	0.01	0.015	-	nil	0.015	-	0.02	0.02	0.02	0.015	0.019	0.019	0.015
Copper mg/l Cu	0.04	0.08	0.04	0.05	0.1	-	0.3	0.05	-	0.03	0.05	0.05	0.05	0.11	0.05	0.04
Silica mg/l Si	>56	>50	50	30	29	-	39	20	-	>50	25	>50	>50	30	35	>50
Conductivity at 25°C µS/cm	250	350	220	172	450	380	258	210	-	200	178	290	370	230	180	200
Oxygen, dissolved mg/l O	1.1	6.5	1.9	2.1	-	-	1.5	2.4	-	1.3	2.5	3.0	1.1	3.8	3.3	3.4
$KMNO_4$ consumption mg/l	13	14	17	20	44	30	22	24	-	13	8	11	16	16	16	7
Sodium chromate mg/l Na_2CrO_4	20	5	5	35	110	-	30	45	-	nil	10	10	40	15	nil	nil
Bacteria:																
Total coliform 35°C/100 ml	nil	32	nil	nil	nil	-	nil	7	nil	nil	8*	nil	nil	nil	1	nil
E. coli 44°C/100 ml	nil	nil	nil	nil	nil	-	-	5	nil	1	7	nil	nil	-	nil	nil

* In the sample taken 15.12.1982 no bacteria was shown.

(cont.)

Table 4-5 (cont.). Water quality in new hand pump wells in other villages (autumn 1982)

Well No.	Jb	27	29	30	31	32	33	34	37	38	40	41	42	43	44	45	46
Sampling date	6/10	6/10	6/10	6/10	6/10	6/10	15/11	6/10	15/11	15/11	15/11	15/11	15/11	15/11	15/11	15/11	15/11
Colour mg/l Pt	50	nil	15	5	450	nil	50	nil	>500	nil	nil	nil	nil	40	nil	10	220
Turbidity FTU	17	nil	5	2	130	nil	15	nil	148	nil	nil	nil	nil	12	nil	nil	60
pH	6.68	6.52	6.74	6.68	6.67	6.74	7 16	6.73	6.98	6.60	6.70	6.51	6.82	7.10	6.01	7.12	6.94
Carbon dioxide mg/l CO_2	2.4	1.7	1.5	2.0	2.2	1.4	5.0	2.2	20	12	21	9	15	12	10	5	10
Alkalinity, total mg/l $CaCO_3$	145	92	125	134	111	111	-	76	-	-	-	-	-	-	-	-	-
- phenolphthalene mg/l $CaCO_3$	nil	nil	nil	nil	nil	nil	-	nil	-	-	-	-	-	-	-	-	-
Hardness, total mg/l $CaCO_3$	181	-	-	-	-	-	62	-	180	81	142	95	137	130	34	74	149
Acidity, free mg/l $CaCO_3$	nil	nil	nil	nil	nil	nil	-	nil	-	-	-	-	-	-	-	-	-
- total mg/l $CaCO_3$	nil	nil	nil	nil	nil	nil	-	nil	-	-	-	-	-	-	-	-	-
Ammonium mg/l NH_4	0.53	0.09	0 45	0.74	2.14	0.55	0.04	0.09	0.98	nil	nil	nil	nil	0.59	nil	nil	1.56
Nitrite mg/l NO_2	0.010	0.010	0.020	0.013	0.050	3.20	0.013	0.030	nil	0.046	0.050	0.277	0.040	0.013	0.017	0.172	nil
Nitrate mg/l No_3	3.10	3.08	3.52	3.08	1.76	24.20	0 88	3.52	nil	4.40	3.52	12.32	2.20	nil	3.08	4.40	nil
Chloride mg/l Cl	5	6	6	4	8	43	7	7	10	10	11	29	10	8	7	7	10
Sulphide, hydrogen	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sulphate mg/l SO_4	nil	nil	2	2	nil	nil	1	nil	1	nil	1	nil	nil	nil	1	2	nil
Phosphorus, reactive mg/l PO_4	0.07	0.09	0.08	0.08	0.06	0.07	0.08	0.09	0.02	0.08	0.33	0.09	0.12	0.06	0.08	0.08	0.07
- acid hydrolyzable mg/l PO_4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
- total mg/l PO_4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fluoride mg/l F	-	-	-	-	-	-	0.63	-	0.68	0.70	0.70	0.62	0.65	0.58	0.62	0.63	0.62
Iron, total mg/l Fe	1.20	0.03	0.40	0.30	4.45	0.12	1.02	0.03	1.50	0.03	0.15	0.06	0.10	0.87	0.05	0.10	1.60
Manganese mg/l Mn	1.70	nil	0.90	2.40	1.30	0.55	0.50	0.30	2.25	nil	0.35	0.10	0.10	3.80	nil	0.15	1.75
Bromine	nil	nil	0.02	0.04	nil	nil	0.04	nil	nil	0.02	0.04	nil	nil	0.03	nil	nil	nil
Calcium mg/l $CaCO_3$	114	75	107	108	87	102	53	75	164	66	133	67	122	92	18	67	129
Chromium mg/l Cr	0.013	0.018	0.015	0.020	0.010	0.015	0.019	0.022	nil	0.018	0.018	0.019	0.021	0.018	0.018	0.019	0.010
Copper mg/l Cu	0.03	0.03	0.05	0.05	0.02	0.03	0.05	0.05	0.03	0.05	0.05	0.02	0.05	0.06	0.03	0.05	0.03
Silica mg/l Si	33	38	22	34	24	21	13	18	25	28	30	16	25	15	13	17	21
Conductivity at 25°C µS/cm	310	216	280	300	250	430	148	182	430	210	350	280	310	290	85	175	370
Oxygen, dissolved	3.2	4.2	3.3	3.6	2.0	3.7	-	2.9	-	-	-	-	-	-	-	-	-
$KMNO_4$ consumption mg/l	7	5	5	5	16	5	3	5	17	4	3	4	5	9	5	4	8
Sodium chromate mg/l Na_2CrO_4	20	nil	10	20	100	nil	-	nil	-	-	-	-	-	-	-	-	-
Bacteria:																	
Total coliform 35°C/100 ml	4*	1	nil	nil	nil	nil*	nil*	nil*	nil*	nil*	nil*	nil*	3	nil*	nil*	nil*	nil*
E. coli 44°C/100 ml	nil	nil	nil	nil	nil	1	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil

* Samples collected 15.12.1982.

content more than 1.0 mg/l. The highest analysed concentration was 9.5 mg/l iron.

Colour and turbidity were also high in these wells, as well as ammonium concentration.

In the future, regular water quality tests are supposed to be done by NWSDB (National Water Supply and Drainage Board). It is the duty of pump mechanic[1] to collect the samples for testing which takes place in a proposed laboratory in Kandy.

4.3. Quality of Water in Hospitals of the Research Area

The main reason for including an investigation into water used in hospitals was the complaints heard about the quality of water in some hospitals in the area. It seemed that no one had ever analysed these waters before. It was also not certain if the new water supplies of the Finnish Project would benefit the hospitals as well.

Six hospitals of the research area were selected for the investigations. These are hospitals that have indoor patients. Only one of these hospitals was not taken into account because it is not generally used by villagers. The detailed information about hospitals of the research area are given in Annex 8. Kandy General Hospital is also used by the people of the research area. Water of this hospital is, however, not analysed in this research. Kandy hospital gets its water from the Kandy municipal supply, like Katugastota hospital which is included in this study although it is a little outside the research area.

Given below is an analysis of water from hospitals at Ankumbura, Boccawela, Madawala, Thittapajjala, Akurana and Katugastota (Table 4-6).

---

[1] Pump mechanic will be a paid employee of the District Development Council. He will generally cover 100-150 community wells for the maintenance work.

Table 4-6. Type and water supply system of investigated hospitals

Name of hospital	Hospital type*	Water supply system
Ankumbura	D.H.	1. Water pumped from own well to tank from where there is pipe connection to hospital, no chlorination 2. V.C. (= village council) supply; pipeline from mountain to the whole town (chlorinated water)
Bokkawela	C.D./M.H.	Water pumped from own well to tank from where pipe conncetion to hospital, no chlorination
Madawala	P.U.	Water pumped from own well to tank from where pipe connection to hospital, no chlorination
Thittapajjala	R.H./M.H.	Water pumped from own well to tank from where pipe connection to hospital, no chlorination
Akurana	P.U.	Water pumped from own well (by the stream) to tank from where pipe connection to hospital, no chlorination
Katugastota	P.U.	Kandy municipal supply - water taken from Mahaweliganga trough tratement system (sedimentation, filtering, chlorination)

* Hospital types of Sri Lanka are explained in Annex 10.

Five of the six hospitals get their water from own wells. The wells are usually closed - opened only for the time of pumping. Anyway, in some hospitals the valve is kept open all the time and all kinds of dirt can be seen in the water (Fig. 4-14).

Fig. 4-14. Own well of one of the hospitals in the research area

Pumping the water to the tank takes place once or twice a day. There are no regular chlorination of water done in any hospitals. It is public health inspector's duty to desinfect these wells - as well as all common wells. This work, anyway, seems to be neglected in all places. Sometimes the reason is said to be lack of chlorin.

There are often breakdowns in water systems of hospitals. In one hospital the water tank had been leaking for some time and rainy water had to be collected to another tank and given to patients for drinking.

Hospital staff of 5 of the six hospitals were quite

satisfied with the quality of water available to them. At Akurana, on the other hand, there was a diverse of opinion. Here the well from which the hospital gets its water supply is very near a stream used by the residents of the area for bathing and washing. In this hospital, it was mentioned that occasionally the hospital well became so dirty that it became necessary to get water from a neighbouring private well.

The physical quality of water was satisfactory in all the hospitals except Akurana, where colour and turbidity figures were rather high. Colour and turbidity show poor quality of water; there can be several reasons for it (discussed in Chapter 4.2.).

The bacterial quality was rather poor in all the hospitals. The analyses should have been taken several times to get more reliable results, but the time available was too short for further analyses. Anyway, at least two samples of each hospital have been bacteriologically analysed, and bacteria could not have been shown in almost all of them. The last samples were taken in rainy season in a very rainy day. Big variations from earlier results is, nevertheless, not to be seen. The biggest variations in bacterial quality were in waters of Katugastota hospital. This water comes from Kandy Municipal Supply, where big variations in water quality have been typical before also.

There is no habit of boiling of drinking water for patients in hospitals. In many places the staff boiled their own drinking water but to the patients they gave unboiled water. Sometimes the relatives of patients brought water to the patient from their home.

Table 4-7. Water quality in selected hospitals in the research area (1982)

	Ankumbura							Bokkawela			Madawala			Phittapajjala			Akurana						Katugastota				
	V.C. supply*		Well supply Ward			Kitchen		Well supply Dispensary			Well supply			Well supply Kitchen			Well supply Labour room			Kitchen			Kandy municipal supply Stand outside pipe	Ward			Kitchen
Sampling date	28/9	6/10	28/9	6/10	8/12	28/9	8/12	28/9	6/10	8/12	28/9	6/10	8/12**	28/9	6/10	8/12	28/9	6/10	8/12	28/9	6/10	8/12	28/9	28/9	6/10	8/12	8/12
Appearance***	co,cl	-	co,cl	-	-	co,cl	-	co,cl	-	-	co,cl	-	-	co,cl	-	-	-	-	-	-	-	-	co,cl	co,cl	-	-	-
Odour****	od	-	od	-	-	od	-	od	-	-	od	-	-	od	-	-	-	-	-	-	-	-	od	od	-	-	-
Colour mg/l Pt	nil	-	5	-	-	5	-	nil	-	-	nil	-	-	10	-	-	80	-	-	60	-	-	5	40	-	-	-
Turbidity FTU	nil	-	nil	-	-	nil	-	nil	-	-	nil	-	-	nil	-	-	20	-	-	18	-	-	2	13	-	-	-
pH	7.00	-	6.53	-	-	6.91	-	5.83	-	-	5.98	-	-	6.18	-	-	7.00	-	-	7.00	-	-	7.02	7.25	-	-	-
Nitrite mg/l NO_2	0.013	-	0.013	-	-	0.010	-	0.073	-	-	0.063	-	-	0.013	-	-	0.017	-	-	0.043	-	-	0.010	0.023	-	-	-
Nitrate mg/l No_3	3.52	-	5.78	-	-	3.52	-	25.1	-	-	16.7	-	-	8.8	-	-	3.52	-	-	3.52	-	-	3.96	3.52	-	-	-
Iron, total mg/l Fe	0.06	-	0.26	-	-	0.03	-	nil	-	-	nil	-	-	0 14	-	-	0.82	-	-	0.69	-	-	0.29	0.53	-	-	-
Manganese mg/l Mn	nil	-	0.10	-	-	nil	-	nil	-	-	nil	-	-	nil	-	-	nil	-	-	0.01	-	-	nil	nil	-	-	-
Conductivity at 25°C µS/lm	60	-	110	-	-	80	-	226	-	-	400	-	-	170	-	-	216	-	-	200	-	-	70	150	-	-	-
Bacteria:																											
Total coliform 35°C/100 ml	-	59	-	65	51	-	36	-	plenty	plenty	-	8	plenty	-	nil	plenty	-	plenty	plenty	-	plenty	plenty	-	-	plenty	nil	1
E. coli 44°C/100 ml	-	nil	-	47	37	-	33	-	plenty	plenty	-	27	nil	-	nil	2	-	nil	plenty	-	nil	plenty	-	-	plenty	nil	1

* V.C. supply is used only in the living quarters of the staff of the hospital.

** Sample from rain water tank (water used for drinking by patients), because the usually used water tank was leaking. Some mold fungus were growing on E. coli (M-FC) nutrient.

*** Co = colourless; cl = clear

**** Od = odourless

5. HYGIENE AND CONSUMPTION OF WATER AND FOOD HYGIENE

Clean water is not the only requirement for good health (but there cannot be health without it). The way people use water, personal hygiene, waste and excreta disposal etc. are also essential aspects of environmental health.

Water is used by individuals for drinking, preparing food, washing dishes, bathing and washing, washing clothes, for toilets etc.

In the research village water is taken from wells or pihillas (spouts). Usually one well is either for drinking or bathing purposes, but there are also wells and pihillas used for both. Washing of clothes usually takes place near a bathing well by using its water. Water for dish washing, toilets and gardens is taken either from drinking or bathing water source.

During the dry season, in some villages drinking water has to be taken from bathing wells, because the drinking wells get dry.

In some villages of the study area stream water is also used. It is very common for people to bathe and wash their clothes in streams but sometimes and in some places stream water is also used for drinking purposes (i.e. during droughts).

5.1. Drinking water wells

Water from drinking wells are of course mostly used for drinking purposes, cooking and dish washing. Sometimes, however, water for washing dishes and kitchen utensils is taken from bathing wells, of which the water is usually dirtier than water in drinking wells. Bathing wells are also cleaned less frequently. People often take water for toilet purposes - for ablutions and in case of water seal latrine for flushing - from the drinking wells, too. Usually

the water is drawn with a bucket and then poured into another vessel but sometimes the same bucket is carried to the toilet. There is big differences in villagers' behaviour in these things. Some people do not allow anyone to use the same pots for fetching water from drinking wells, some on the other hand are quite careless.

In the village area drinking wells are usually cleaned 1...3 times a week. Some people do it weekly (even twice a week) but some on the other hand clean them only once in two months or even less frequently.

The procedure of cleaning wells will not be described in detail here as it is given in the report by A. Kelles-Viitanen. However, when cleaning a well, it is emptied of all the water by a couple of people using buckets and any mud or debris is removed. The walls and bottom are usually scrubbed with coconut husks and seepage holes if any are blocked. After that it is just left until the water fills up in the well. Some people (at least one in the study village) empties the well again after that and then lets it get full to get really clean water. The system in cleaning bathing wells is similar but is not done so often - mainly because bathing wells are usually much bigger than drinking wells.

Chlorination of wells is not practiced in villages (the possible reasons for this have been discussed in Chapter 4.1.). In this village only one bathing well has been chlorinated recently. During epidemics the Public Health Inspector (P.H.I.) is expected to visit the village and desinfect the wells.[1] This happened recently in one village of our research area when two children died of shigellosis in that village. For desinfecting the wells bleaching powder is used.[2] This same desinfectant is used by the Finnish

---

[1] Actually the P.H.I. is expected to desinfect public wells (including hospital wells) regularly but is seems that this kind of preventive work is not done at all in the research area.

[2] Bleaching powder is a mixture of calium hydroxide, calcium

Firm when chlorinating the water of new hand pump wells.

One informant mentioned that he cleans his well which is situated on a paddy field always after pesticides are sprayed to the paddy. He also cleans the surroundings of the well with brush.

Many of the villagers try to prevent surface rain water from flowing into their wells. Many of the wells, however, are situated on paddy fields[1] and they are not protected properly. As explained before, some of them are just mud holes without any protection. So, during rainy seasons when the paddy fields are really flooded, the water from the fields can easily flow into the wells. Sometimes these wells are abandoned during the rainy period or some people at least then boil this water if the well is used to obtain drinking water.

Only two of the traditional wells in this village are covered with tin - one only at nights (well in Fig. 5-1). Many people believe that the water in a small well is purified when the sun shines into it and that if they cover the well the water gets putrid. They also like to see the bottom of the well all the time. Anyway, most of them accept the completely covered hand pump wells because "some medicine has been put inside the well". They also like the new wells because they are easy to use.

In almost all wells some mosses can be seen in the water (Fig. 5-2). As mentioned before, most of the villagers think it is good for the water to have some drya sevele or gal sevele in wells to absorb mud and other dirt from the water. When cleaning the wells mosses are always removed but new mosses grow very fast again.

---

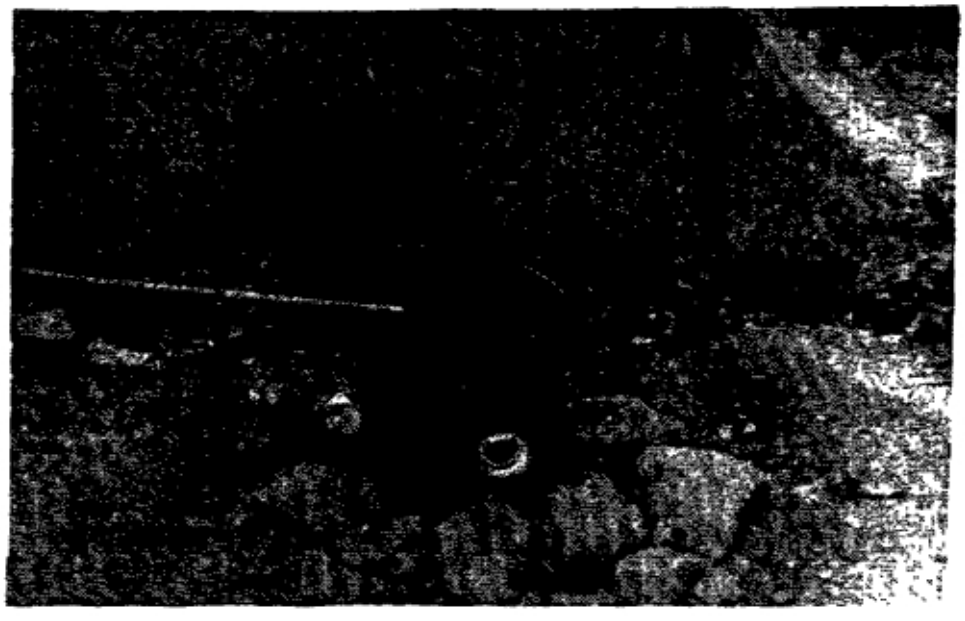
chloride and calcium hypochlorite and has 20 % ... 35 % available chlorine.

[1] The wells are often located in paddy fields because these fields are always in low-lying areas where there is ground water.

Fig. 5-1. Drinking well with tin cover

Fig. 5-2. Lot of diya seleva moss in bathing well

Fig. 5-3. Mudhole on the edge of paddy field (above). Water from this well is led through s-lon pipe into a barrel to the garden of one temple (below). Water is used by three monks, drummers of the temple and paddy field workers.



Sometimes fishes (kaneo) and frogs (gembo) are also put into the well because they eat mosses and other dirt. They are also considered as indicators of poisons in the water if they are found dead in the well. There are sometimes also crabs in the wells, but these are not considered as good indicators of water.

During the Sinhala New Year (13.-14. April) festival rituals, wells are also given much importance. It is customary among the Sinhala rural folk of this village to make an 'offering' of uncooked items of food such as a handful of rice, chillies, salt, onions, goraka,[1] turmeric,[2] betel leaves, coins and even dried fish during the festival. Many make this 'offering' right into the well, while others who feel that even though an 'offering', these materials could pollute the water, leave them at the edge of the well.

It would be interesting to see what happens at the hand pump wells during this New Year ritual. It is very likely that the 'offerings' would still be made at the well, and as one villager observed the coins would be put into the well through the small gap beneath the handle, which has already been discovered by little children at play who drop pebbles through it!

One other New Year ritual among the Sinhalese is to take a bottle of water from the well which they keep through the whole year in the bottle. At the next New Year the old water is thrown away, sometimes back to the well, and the bottle is filled again.

Another little game of children at the new hand pump wells could probably cause some contamination to the well water. One child puts his hand against the opening of the pipe and another child begins to pump. As a result of the

---

[1] The dried rind of the fruit of goraka tree is astringent and antiseptic and used for washing ulcers and for anorexia and chronic dyspepsia - also employed for flavouring curries (Medicinal Plants used in Ceylon, Part 3, p. 67).

[2] Turmeric (Sinh. kaha) is a spice which has an antiseptic effect.

pressure that builds up inside the pump water begins to rush out through the small hole under the handle.

5.2. Fetching and Storing Water

Water from wells and pihillas is usually fetched in buckets or aluminium or clay pots. The shape of the pot is such that it is easy to carry in the bend of the elbow against the hip (Fig. 5-5).

Fig. 5-4. Collecting water from small drinking water pihilla to buckets and pots. (The water comes from a spring up the hill along the groove of a bamboo or areca trunk split in two and connected up to form an open half round water-way.)

Fig. 5-5. On the way to the well

Other utensils such as kettles, tins etc. are also used. The villagers also use traditional receptacles such as those made of the lower part of the fronds of the areca tree (Fig. 5-6).

Fig. 5-6. Traditional "bucket" for fetching water from well

Fig. 5-7. Piece of areca palm frond bark used i.e. for making receptacles as in figure above

Fig. 5-8. A shop selling all kinds of utensils. Note the different kinds of buckets, aluminium pots, and basins used for fetching water

Utensils are rinsed with water at every fetching time. Washing with soap is rare and it also depends on the type of vessel. Some clean their pots with sand before taking water from wells. This practice could be one reason for microbial pollution of drinking water - even if the well water was pure.

Sometimes the same buckets used in toilets are used for fetching the water from drinking wells. This can easily be a source of microbial contamination of wells.

During the rainy season some people collect rain water to some basin and use it usually for washing purposes. Families which do not have a well near the house collect rain water also for drinking purposes.

Water is sometimes stored in the same pots which are used for fetching and they may be kept either inside or outside the house - in most cases inside. The empty pots are often kept ouside (Fig. 5-9).

Fig. 5-9. Water and cooking pots kept outside the house

Often water is stored in earthenware pots. These pots are usually dried over hot coals burning through paddy husk

before taking them to store water. In fact they are dried quite frequently in this manner. This gives the water a special smoky taste that is considered tasty. Due to evaporation through its unglazed surface the water kept in these pots keeps cooler than in aluminium pots. Water is often at first boiled and then put into this kind of pot.

Another special pot used for storing water is a clay "goblet" (Sinh. gurulethhuwa) which has a distinctive shape with a broad lower part and a long neck with a small lid over it.

5.3. Domestic Consumption of Water

5.3.1. Boiling and Filtering

According to the staff of the hospitals of the research area the most common reason for bowel diseases is the lack of pure drinking water and people's carelessness to boil it.

Almost 90 % of the villagers who were asked whether they boil their drinking water or not, answered in the affirmative. Some of them, however, said that they do not boil it always. Sometimes when they were very thirsty they drank unboiled water, and on working days they could not find the time to boil the water. In many cases water is boiled only during the rainy season when some muddy water pollutes the wells.

According to the facts revealed by the schoolchildren 78 % of their homes used boiled water. 6 % of these families boil the water only when it is raining and about 5 % in case of sickness (Annex 7).

According to those children in 33 (53 %) homes the whole family uses boiled water. Referring to the habit of boiling water, 23 % of children answered that people can get sick by using unboiled water and same number of

children answered that boiled water is clean and has no germs. About 70 % of them have a positive response to this question.

Three reasons for not boiling have been identified. Firstly the villagers are often not educated to develop this habit and they do not understand the importance of it. Usually water is not understood to relate to diseases. Water is boiled only when there are visible impurities in it as during the rainy season when well waters get muddy, or when water has some colour - like the rusty colour of the water of some new hand pump wells - discussed earlier. Secondly, on working days people do not have time for boiling water, and thirdly people like to save fuel wood which is usually collected from the jungles by women and which often takes many hours of the day.

The degree of boiling seems to be a problem. People are usually adviced to boil the water at least five minutes. Midwives of villages advice mothers to boil to water for 20 minutes if it is used for instant infant formulas. Anyway, all the informants in this study said that they only boil water until it begins to bubble.

In tea shops of villages they have a system where the water is boiling all the day. It is a small stove that is filled with paddy husk which is sometimes damped with kerosine oil. The dust is fired in the morning and burns the whole day. The water pot (usually covered with a plate) is kept over the oven all the time.

In Kandy hospital the water used for patients is always boiled (for 20 minutes). In the small hospitals of the research area this is not so. In all these hospitals - according to the analyses discussed in Chapter 4.3. - the bacterial quality of water anyway is quite unsatisfactory.

The habit of filtering the water is more common among the villagers than boiling. Usually filtering takes place at the well when fetching the water. The water is taken from the well for example with a bucket and poured through a piece of cloth to a pot. The piece of cloth is usually

kept by the well and often looks quite unclean. Some of the villagers are so used to filtering that they have put a filter cloth also to one of those new hand pump wells. In this particular well the quality of water is very good (hand pump well no. 8, Fig. 5-10) and now by this practice this water used for drinking can get contaminated because of the dirty cloth used for filtering.

Fig. 5-10. Filter cloth in new hand pump well

Sieving water through a cloth of course can prevent the spreading of some water-related diseases, i.e. worm diseases but not those caused by bacteria, viruses etc.

There is a Buddhist ceremony that takes place in homes

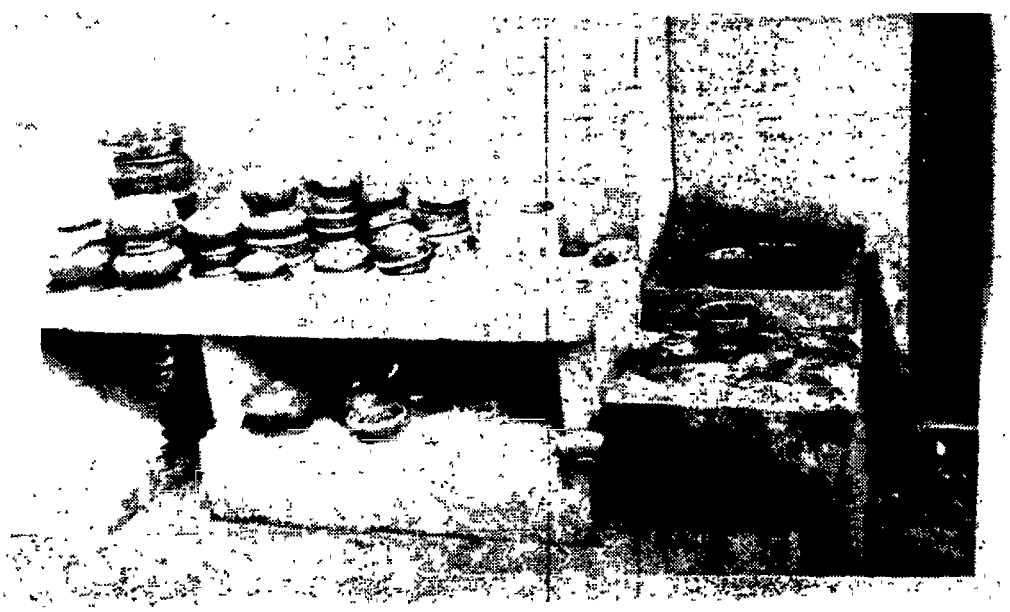
to ward off evil and protection from diseases etc. This is called pirith ceremony (explained in detail by A. Kelles-Viitanen). For this ceremony a new small well is dug near the house (in any place where water is found). From this well water is taken into a pot. This water pot plays an important role in the ceremony which lasts all the night. In the morning after the ceremony all the participants drink water from this pot which is believed to be blessed at the ceremony and therefore is of beneficial effect. The water used in this ceremony is not boiled but usually filtered and some jasmin flowers and turmeric are put into the water.

5.3.2. Cleaning and Washing

Water for washing of dishes is taken either from drinking or bathing wells. It seems that drinking water is more commonly used for this purpose but the difference is not very clear. There is usually a difference between quality of water in drinking and bathing wells and it is to be desired that drinking water is used for washing, too, if available.

Water for washing dishes is always used cold, never boiled. Vim or soap is usually applied - washing liquids are not commonly used in villages (they are expensive and often not available).

Fig. 5-11. Dish washing place in a big house in the village



Washing of dishes takes place outside the house (near the kitchen door) and utensils are also stored in the same place until taken into use.

Cleanliness of the house is usually considered important among villagers. One reason can be found in the explanations given by one villager:

> "... gods always visit very clean places, sometimes they go to very clean houses. When they come, the house is very good. ... If the house is not clean - if wastes are put everywhere and if children always defecate everywhere and people are always dirty - the gods never visit such places... It is good if the gods visit the house ..."

In houses with mud floor the floors are regularly rendered with an application of cow dung to maintain them.[1] Cow dung is usually mixed with water and clay and spread on the floor by hands. Rendering the floor with cow dung is believed to keep the floor clean and prevent worms from coming through the floor. It is also believed to be good for the feet.

When cleaning floors sometimes also kaha vatura[2] (turmeric water) is sprinkled to the floor.

Washing of clothes: Clothes are usually washed at the bathing place - by a well, pihilla or stream. They are washed with soap (i.e. Sunlight) usually on a stone. Sri Lankans have a special way to wash clothes by beating them on a stone (Fig. 5-12). Although it is taught in schools that beating ruins the clothes and is quite unnecessary, it remains the most common method of washing clothes.

---

[1] According to one villager cow dung is not applied on the floor on Tuesday, Friday and Sunday as the gods would be angered and people can easily get diseases as a result.

[2] Kaha vatura, water with turmeric, is commonly used as an antiseptic in Sri Lanka.

Fig. 5-12. Young girls washing clothes by a stream

A greater part of the washing of clothes is done by mothers and daughters, although boys and men wash their own clothes sometimes.

After washing clothes are spread on bushes, on branches of trees, rocks, or - very commonly - on the ground to dry (Fig. 5-13). Some people in the village have clotheslines.

Fig. 5-13. People washing clothes and bathing by a stream

In Sri Lanka there is a caste called dhobi (washers) whose work is to collect people's clothes and wash them. These dhobies are potential communicators of diseases as they wash all the people's clothes and they often have to use very unclean water.

Hospitals use dhobies as well to wash the bedlinen of patients. It has been a much discussed topic in Sri Lanka to get mechanised laundries at least for the biggest hospitals. Hospitals are also often short of linen and often bedlinen is very dirty and it has become quite a common practice that patients enter the hospitals with their own linen.

5.4. Bathing and Personal Hygiene

In the research village people use wells and pihillas for bathing. In villages where they have streams people rather bathe in them because running water is considered the cleanest place to bathe as the water is all the time moving.

Villagers think it is important to bathe often not only to get clean but also to cool the body. It is believed that regular cooling of the body is good prevention against many illnesses.

Most of the villagers in the study village bathe at least thrice a week (46 % of informants). According to the adults interviewed, children usually bathe every day but only 5 % of schoolchildren (in the interview made in two village schools) said that they bathe daily. Most of them bathe thrice (23 %) or four times (21 %) a week.

Soap is commonly used when bathing and sometimes a handful of coconut coir or even a stone is used to get the skin clean.

Bathing takes usually place after washing clothes (Fig. 5-14). Sometimes it is quite common to see people and animals (buffaloes and elephants) bathing near each other in a stream.

Fig. 5-14. People bathing

Some people do not bathe on Tuesdays and Fridays for fear of angering the gods, when they believe, if angered, they would cause diseases such as measles, chicken pox, mumps and some eye infections. Women generally do not bathe - this means bathing to include washing head - during menses. The midwife of the village advises the women to bathe on those days but it is so deep in tradition that some women anyway do not accept this advice.

When a young girl attains puberty it is customary that she is allowed to bathe on the first day of the period but after that she has to remain in one room at home until an auspicious day is given for her to bathe. During this time (often 9 days) she does not bathe at all - only washes her face and mouth.

People here do not bathe for about 7-14 days when they have the so called god's diseases like chicken pox (pappola), measles (sarampa) and mumps (kammulgaya). After that (if disease has gone) they go bathing - preferably to a pihilla, as it is believed that "just as the water flows the disease will go away, too". For example when one gets chicken pox,

in 14 days no medicine is given. After that patient is taken to bathe, soap is not used at these baths - instead a paste of turmeric (kaha), grated coconut and margosa (kohomba[1]) leaves are applied to the skin and then washed away. The patient is bathed like this every morning for seven days.[2]

In one house in the village a man had got chicken pox and did not bathe for one month. All what was left over of the food of the patient during this time was kept in the room of the patient the whole month. After the patient went to bathe, the leftovers of food were buried in the garden.

There are also special times for bathing like New Year's morning and after coming from funeral house or puberty house.[3]

People in the research village are not satisfied with their bathing wells. Too many people use one well[4] and by the afternoon water is usually very dirty. That is why the best time for bathing is in the morning. All the bathing wells are situated on paddy fields. That is why the water often is muddy. Sometimes buffaloes that are working on paddy fields come to drink from wells (both drinking and bathing wells) that are on the field. This is one source of contamination. When washing clothes at the well the dirt and detergents used go to the well.

---

[1] "A strong decoction of the fresh leaves of margosa tree has antiseptic properties and is used for washing wounds, ulcers and as bath for patients recovering from chicken pox and childbirth." (Medicinal Plants Used in Ceylon, Part 4, p. 53)

[2] In front of the house in which measles patient is they hang areca tree flowers. One (inner) side takes some bacteria, other side tells to people that in the house somebody has god's illness.

[3] Puberty house means a house where the girl with her menses is kept (in one room, usually for nine days).

[4] On dry season even 50 families can come to bathe to the same well.

The bathing wells are not cleaned very often either because they are usually quite big and deep and difficult to empty. Many skin and eye diseases can spread through impure bathing water, as well as worm diseases that are very common in the research area.

One problem with bathing places is people's habit to defecate near a place where there is water because it is easier for the ablutions. So, surroundings of some bathing wells and pihillas are polluted with human faeces which are also likely to contaminate water in these places. It is also a habit of some people to defecate when they are bathing in streams.

There is a real need of bathing wells in the research area. The Finnish Firm has so far no plans to construct any bathing wells. Now when the villagers are getting new drinking wells it would be a good idea to construct some of those old drinking wells to bathing wells. The idea of covered bathing wells seems to be quite strange to villagers.

The most acceptable bathing place is one with flowing water like in pihillas of which they have a few in the villages. The water to these comes from spring on the hills to a tank through a pipe or channel. From the tank water flows through a small bit of pipe under which one can bathe like under a shower. This kind of a system with a covered tank and a pipe with a closing device (to prevent continuous flow of water) would be suitable.

Fig. 5-15. One type of bathing pihilla

Personal Hygiene

The practice of washing hands after toilet and before eating is common among some villagers. There are, however, a lot of people who do not bother to do this. Washing usually means only pouring some water on the hands and no soap is used (more about washing hands after toilet in Chapter 6).

In Sri Lanka people eat their food with fingers (only the right hand is used for eating and the left hand in toilet). On the dining table there is usually a small water pot (finger bowls) in which people wash their hands before and after eating. Anyway, the more common habit seems to be

to wash the hands thoroughly only after a meal when the hands are soiled with food. This, again, shows that only dirt than can clearly be seen is understood, as mentioned in the discussion about villagers' concept of good water.

Washing of hands, legs and face takes place at least in the morning - often more frequently during the day - usually at the drinking well. The mouth is washed vigorously at the same time. I do not speak here about washing or brushing teeth because in this exercise the mouth is rinsed with water and teeth usually rubbed with the forefingers. Often some tooth powder[1] is also used. Tooth powder is relatively cheap and so poor villagers can also afford to buy it. Sometimes teeth are rubbed with a piece of charcoal or even with brick dust. It is also common that people working on paddy fields wash their mouth with the water that is in the field.

Nursing mothers are seldom concerned about cleaning their breasts before feeding the baby. They nurse their babies where and when ever necessary and do not bother even to look for any water for cleaning. Midwife of the village, however, advices mothers to do it. Cleaning of clothes - even underwear - is often neglected among poor people.

5.5. Food Hygiene

All over Sri Lanka the food - even vegetables - are usually very well cooked. Cooked food, however, may be kept for hours. In rural areas refrigerators are very rare and food is usually stored in kitchen tables. Often the rice and curries that are left over at dinner are eaten the next morning as breakfast. Anyway the use of hot spices helps a little in the preservation (Sri Lankans are said to eat

---

[1] Commercial tooth powders are made of burnt paddy-husk flavoured with herbal medicine or mint.

the hottest food in the world).

The serving and handling food in small eating places and tea boutiques is a real problem. In these places they sell e.g. hoppers,[1] bread and other small eatables and sometimes rice and curry. These places are usually really unhygienic and are a potential health hazard to their customers.

In the research village the food for these places is made by some village women in their homes. Some places have their own - usually very unclean - kitchens.

I present here some of my own observations of these kind of places:

> "The toilet of the eating house is situated outside it - three meters from the outer exit of the kitchen (there was no door). The place between kitchen and toilet is actually the dumping ground of the eating house - there are all kinds of garbage with a lot of flies and crows. The toilet is also in a very bad condition; it is water-sealed one but there was no water available. Flies were flying between toilet, dumping place, kitchen and shop. In the shop all the food was glazed with flies."
>
> "The place has a water pipe connection. As there is no water on tap throughout the day a huge cement tank (not covered) is filled up with water every morning and this water is used for cooking and for drinking water of customers. The tank, like the whole kitchen, is very dirty. According to the owner that water is only used for customers, the staff gets their water from a well because there the water is cleaner. The floor of the kitchen is broken and is like a dumping place - all kinds of food wastes can be seen there."

Hundreds of examples like these could be found in the research area.

---

[1] Hoppers are a typical Sri Lankan food made of rice flour, coconut milk and yeast.

Customers of these places can freely touch the food (without buying). According to regulations the food in these places should be kept in showcases. In the places where they have one it is usually very dirty. The eating houses need to be licenced and such a license is issued on the recommendation of the Medical Officer of Health (M.O.H.) and it is the duty of the Public Health Inspector to supervise the hygiene of the place.

The bakery of the research village is also in a very unhygienic condition. The doors were all the time open - for visitors and dogs! There are strict hygienic regulations which apply to these places, too, but such regulations are neither followed nor supervised carefully.

6. ENVIRONMENTAL SANITATION

6.1. Excreta Disposal

There are 189 houses but 180 private latrines in the research village. Some of the latrines are used by two households and therefore every family uses a latrine - either pit or water seal[1] type. In addition to these there are three common latrines and three urinals at the school. Most of the latrines are pit type and are not quite satisfactory hygienically.

6.1.1. Latrines of the Research Village

Latrines of the area could be classified under 7 types on the basis of seats, walls and roof.

1. concrete slab, brick walls, permanent roof
2. concrete slab, mud walls, permanent roof
3. concrete slab, mud walls, temporary roof
4. stone and mud pit, mud walls, temporary roof
5. stone and mud pit, thatch walls, temporary roof
6. stone and mud pit, thatch walls, no roof
7. stone and mud pit, no walls, no roof

Permanent roof means here concrete roof or one made of tiles or tin. A temporary roof is thatched with coconut leaves (cadjan) or hay. Walls in types 5 and 6 are also usually made of cadjan (about 40 % of toilets have thatch walls).

Most of the latrines are of type 4 or 5. These are pit latrines made of such a material that is quite difficult to keep clean.

---

[1] In schoolchildren's questionnaire some pupils informed that in some homes they have also bucket latrines (Annex 7). In this village, anyway, there are only pit and water seal lavatories and obviously those children consider latrines where they bring water by buckets, as bucket latrines.

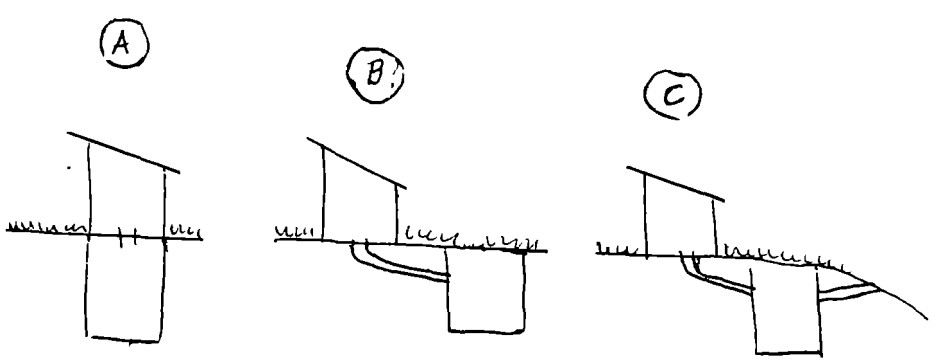
According to observations of the investigators of the Finnish Project many of the toilets in the research village were in a poor condition; 61 % of pits, 47 % of slabs, 66 % of walls and 65 % of the roofs were not satisfactory. (The pits were either collapsing or not deep enough. The slabs had more holes than were needed or the floor was too rough or too difficult to keep clean and the walls were leaking, etc.)

In Figures 6-1 ... 6-10 there are examples from different kind of latrines in the village. Hygienically best types are those seen in Figures 6-1 and 6-2. Unfortunately these are not very common in the village.

Fig. 6-1. Water-seal latrine. Not common in the village

Fig. 6-2. Pit latrine with concrete slab, brick walls and concrete roof, and water connection inside the toilet. Not common in the village

According to tank situation and ventilation of latrine three types can be found in the village:



All the pit latrines belong to type A (more than 80 % of all latrines). Almost all the water seal latrines are like type B. Only some toilets (about 5 %) in the village are equipped with ventilation pipe (C). In pit latrines the ventilation would prevent the transport of flies in the pit. There is a pit lining only in about 20 % of the latrines.

According to interviews conducted by the Finnish Project the average depth of a pit latrine is 15 ft (4.5 m) - the lowest ones are only 3.5 feet (1 meter) deep. They are usually those poorest houses with poorest latrines that also have the smallest pits. In these latrines they do not always have water-proof roofs. That is why pits often overflow during the rainy season.

According to some leading persons of the village the lack of satisfactory toilets is the biggest health problem in the village. Most of the existing latrines are in need of repair. One reason for the poor condition of many latrines is that the people are not willing to spend money on repairing them.[1]

---

[1] According to a research report by a Danish project: "Many people in the study area give very low priority to the construction of a latrine. A house, a wristwatch, a transistor radio, a tape recorder, etc. are more attractive and more prestigious. Few people will therefore on their own spend money on the construction of a latrine. The method of defecation is squatting. Any type of sanitation facility which includes a squatting plate is socially acceptable." (Kampsax - Kruger 1982, p. 6-130)

Fig. 6-3. "Wattle and doub" latrine with hay roof

Fig. 6-4. "Wattle and doub" latrine with tin and cadjan roof

Fig. 6-5. One kind of a pit latrine

Fig. 6-6. Pit latrine with coconut leave (cadjan) walls

Figs. 6-7, 6-8. Pit latrines

Fig. 6-9. Latrine for children of one family

6.1.2. Location and Use of Latrines

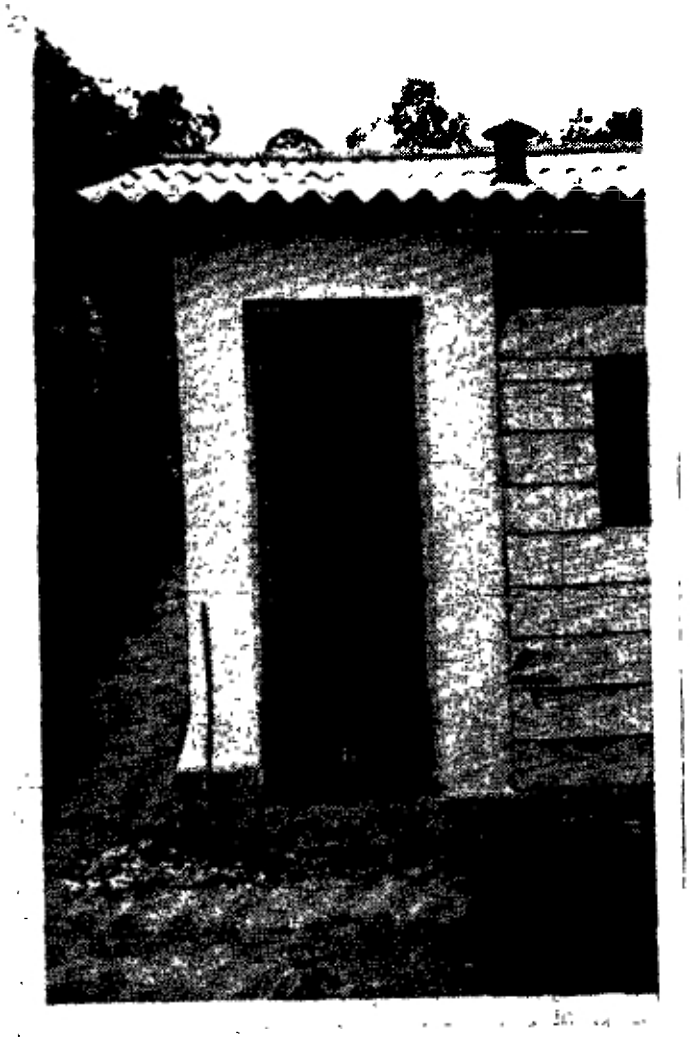
Latrines are usually quite near the house; according to interviews conducted by the Finnish Project 57 % of the latrines are nearer than 10 m from house (Table 6-1).

Table 6-1. Distance from latrine to house

0-5 m	25 %
5-10 m	37 %
10-20 m	26 %
>20 m	12 %

Only place in this village where latrines are attached to the houses is the housing scheme built by the state. It consists of 20 houses (Fig. 6-10).

Fig. 6-10. Water seal latrine attached to the house



Even if the latrines are not very far from the house they can be in very difficult places. People have to climb up and down the hill. That is why urinating and defecating during the night usually takes place in the garden. That is also why children often do not use latrines.

In some families the children do not use toilets at all because they are afraid of the pit. In these cases children urinate and defecate in the garden and the mother carries the faeces to the toilet or throws it under the trees. Small children's faeces seem not to be considered as dirty things as adults' faeces. So, children are usually allowed to defecate everywhere.

At the day time when people are at work far from their houses - in paddy fields, collecting fuel wood etc. - they usually go to the nearest bushes to urinate and defecate.

It is quite generally known that latrine should not be built near wells - this seems to be taken into consideration when latrines are built in the village. However, the research area is quite hilly and often houses and latrines are situated on the upper slopes and wells down on the valley. During the rainy season when latrine pits often overflow the fecal contamination of well water is likely. Sometimes people also defecate directly on the slope because of the location or bad condition of the latrine. Rain water then easily washes the faeces down to valley.

6.1.3. Water Use in Latrines

In latrines water is needed for ablutions (toilet paper is not at all used in rural Sri Lanka) and in water-seal latrines also for flushing. Water to toilets is usually carried either from bathing or from drinking wells - both are used almost in equal numbers for latrine purposes. Water is usually taken from the well with a bucket and then poured into a pot or tin that is generally used only in the toilet. In a few cases there is a tank for water outside

the toilet (Fig. 6-11). Water to these tanks has also to be taken from wells. Anyway, it seemed that these tanks are usually empty. And in most places there are no water pots to be seen in or near the latrine. This, however, does not mean that ablutions are not done at all,[1] but it is the practise that each person carries the water to the toilet from where it is available. (That is also why people like to defecate near a place where there is water available, i.e. by the streams and near wells.)

From the people interviewed, 74 % said that they wash their hands after toilet. Some people said that they also use soap with hand washing. But even when there was water near the toilets there never was any soap and sometimes I had the feeling that people answered like this because they know they should wash their hands with soap after toilet.

Fig. 6-11. Water seal latrine with a water tank

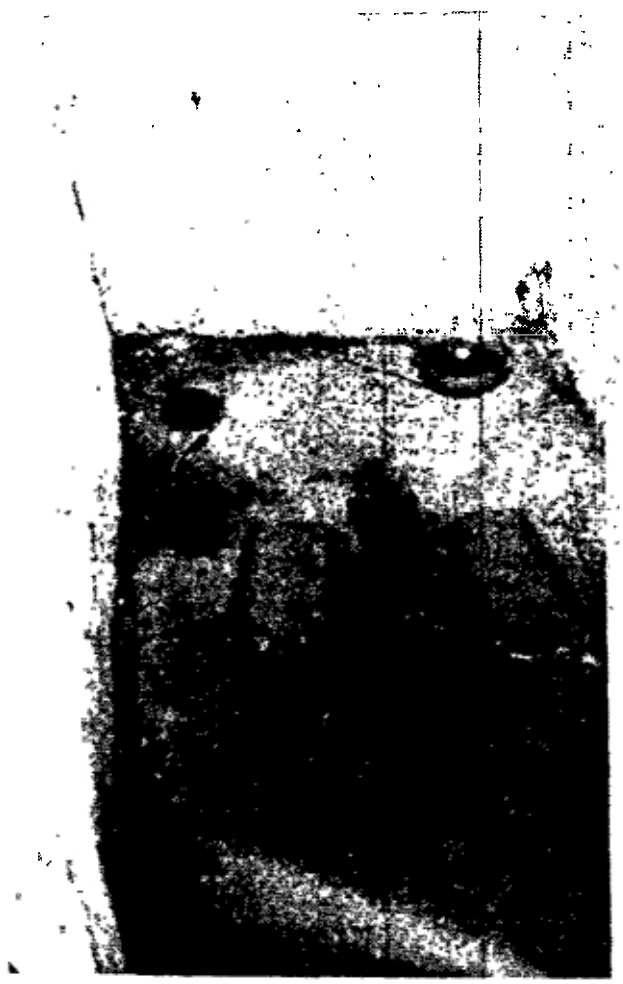
[1] According to a proverb, Sinhala people use even their own urine for ablutions if there is no water available for ablutions. They can also somehow manage with a very little amount of water, but ablutions are always done, however.

According to results of the schoolchildren questionnaire almost all of the children wash their hands before eating but not always after toilet (Annex 7).

Usually when washing hands after toilet only some water from pot is poured on left hand (only left hand is used in toilet). So, even when they wash their hands the degree of washing is not thorough.

According to one P.H.I. (Public Health Inspector) who had been working in this area, at most 5 % of these people really wash their hands after defecating.

Fig. 6-12. Pit latrine with water pot for ablutions



6.1.4. Filled Latrine

It is not a habit in Sri Lanka to empty the latrine after being filled up. Instead a new pit is dug and a new latrine built. In water seal type, where the tank is not just under the latrine building, they can make only a new tank and lead the bore hole from the old toilet to there.

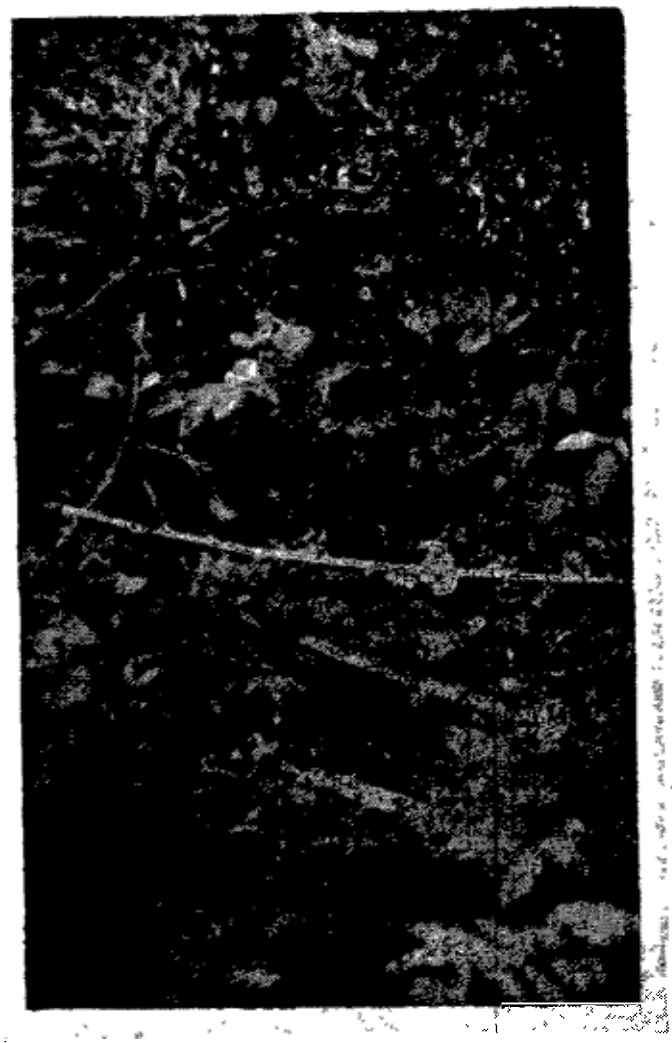
Only in one house in the studied village they had a water latrine which they had once emptied so that the sludge came through a pipe from the latrine tank to a pit made into the garden.

In the two years old housing scheme (20 houses) they have water seal toilets with tanks that can be emptied. Those people living there did not even know what happens when tanks get filled. They said that they would not empty them themselves. They consider it a very dirty work.

6.1.5. Common Latrines

There are no common toilets in the research village - except in the schools. Near the building where there is the post office, grama sevaka office and some shops there is one "so called latrine" which has no roof and walls but only the pit (Fig. 6-13).

Fig. 6-13. Common "latrine" used by staff of post office, grama sevaka office, one tea shop and two other shops

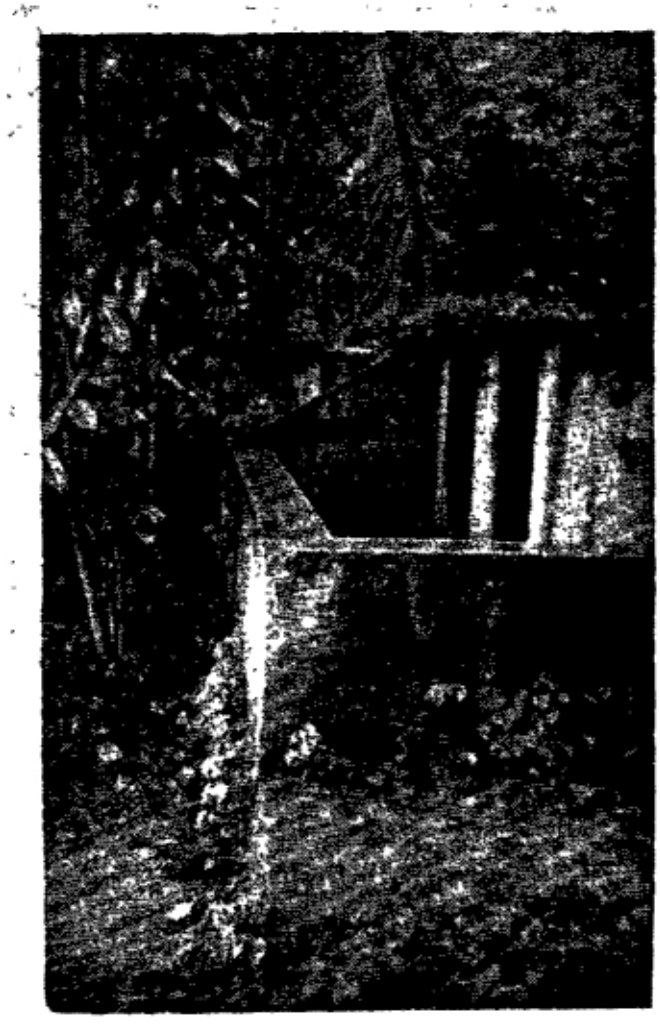


At least six people use it daily, with all the other shops and small eating places the situation is the same. People working in these places often have to walk long distances to go to latrines of their homes. In other villages the situation is similar. In a small town near the research village there are many tea shops and none of them have any latrines. There are also no common latrines. People sometimes have to wait for hours for buses in town centre and only places where to do their needs are the bushes by the stream that is flowing through the town. Some people defecate

even to the stream.

In this town the government has built a common water seal latrine on a hill where there is no water available and where it was very difficult to go. This place is now completely abandoned (Fig. 6-14). Nobody took care of the cleanliness of the place and nobody ever used water there - because there was no water. Now some people use the surroundings of this latrine building as a toilet. Every place in and around the latrine building is clogged with human faeces.

Fig. 6-14. Abandoned common water seal latrine



The problem with the common latrines is that nobody takes responsibility to keep them clean. Actually it is Public Health Inspector's duty to supervise the condition of latrines but these works seem to be often neglected. Also users of these latrines are not voluntarily inclined to flush the latrines after use - they seem to think that the next one can do it.

In hospitals they have common toilets for outdoor patients outside the building. These seem to be in a terrbile condition, too. They are also water seal toilets but water system is not working - taps are broken etc. In one hospital the doctor said that the hospital does not care about those toilets because there are other people using them - not only hospital patients.

With schools the situation is better. In every village school they have separated urinaries for girls and boys and at least one water seal of pit latrine for defecating. These are usually in quite good condition; sometimes there, too, some faeces can be seen on the floors of urinals.

In one Muslim village in families where they do not have their own toilets and there are no common toilets the men often use the latrines of the Mosque. Women of course cannot do it (women are not allowed to go to the Mosque). So they have to go to the bushes.

6.1.6. Pit Latrine or Water Sealed?

Much has been discussed by villagers about latrine types they like to have, after they heard about the sanitation plans of the Finnish Firm (discussed in Chapter 6.2.7.).

The water seal latrine is usually the hygienically best type for rural areas. Even some correlations between infant mortality and availability of toilet facilities and types of toilet have been given in "Scientific Report"[1]

---

[1] Flik-Lagerwey and Antonipillai 1982, p. 1.

(Table 6-2).

Table 6-2.

Type of toilet facilities	Deaths per 100	
	post natal	child
Flush or water seal	16	21
Bucket or pit	20	29
No facilities[1]	31	41

The table indicates a difference between even water seal and pit latrines. Nevertheless, water seal is a better alternative only if there is adequate water and water should be available quite near the toilet. Lack of sufficient water is one of the main reasons for the deplorable condition of water seal toilets - especially common toilets. A pit latrine is the best alternative for places which are affected by water shortage - even seasonally.[2]

In the research village even the villagers by themselves say that they prefer pit latrine to water seal. According to schoolchildren questionnaire that was made in one Sinhalese and one Muslim village about 50 % of children considered pit latrine as most suitable toilet (Annex 7).

---

[1] Lack of toilet facilities is a real problem on the estates where even 20 families have to use one toilet.

[2] According to Kampsax-Krüger 1982 (p. 6-72): "In the fifties water seal latrines were introduced. This system generally appealed to the rural people because it saved them of the smell and the flies which were usually connected features in the pit system. In certain areas where water was not available within close proximity to the latrines, we have seen people abandon the latrine or break the water sealing device, thus the latrine became an ordinary pit latrine. In some cases due to lack of proper levelling, the flush system has not worked properly. This caused demand for more water than anticipated. Instead of wasting a lot of time on drawing water at each latrine visit, many villagers return to the old practice of defecating in the bush."

A good system to protect smell and flies in pit latrine is - as used by some villagers - to cover the pit with something that is easy to remove when the latrine is used (Fig. 6-15). The cover would also prevent rain water to flow into the pit.

Fig. 6-15. A latrine with a pit cover

6.2. Waste disposal

Waste disposal system in rural Sri Lanka seems to be very simple. People just put wastes here and there and small dump places can be seen everywhere in gardens and by the

roads.

Only some people dig a pit for household wastes in the garden, some even make a small compost pit and use it as fertilizer for vegetables or trees, sometimes also for paddy field. This practice unfortunately is not common at all. Few people also burn their wastes and put the ash to plants in the garden.

People usually know that they should not just put wastes all over the garden. Already in school it is taught how to make a compost, but only few people care to do it. When wastes are just put somewhere, dogs, cats, rats and birds eat and spread them around. They are also breeding places for mosquitos and flies.

The most dangerous practice is to put garbage into streams where people also bathe. It is believed that flowing water is a good place for wastes because they are carried away.

Less than 30 % of the interviewed villagers said that they dig a hole for wastes. Others just put it somewhere in the garden - usually the place is near the kitchen door. Waste water is also just thrown into the garden - usually under some tree.

The village shops and eating places have also the same waste disposal system. Most common place for garbage is behind the kitchen door.

Fig. 6-16. Household garbage put into the garden - common system

Fig. 6-17. Compost pit in the garden - not common system

The situation in small town which do not have centralized waste collecting system is worse. Huge amounts of garbage can be seen by the edges of roads and streams. Even when there is some collecting system wastes are at first just put by the streets from where the lorries collect them and drive them to dumping places that are sometimes right in the middle of the town.

Fig. 6-18. Garbage

Fig. 6-19, 6-20. Garbage dump behind the bazaar of one town. Also wastes from some surrounding areas are brought here. (The garbage van in the picture belongs to Kandy municipal and brings wastes from Kandy town to this bazaar area.)

Fig. 6-21. Fish monger's lorry in front of the same bazaar (note the flies)

Advice on how to dispose wastes reaches the people at all school levels and at community level by Public Health Inspectors and midwives, who go from house to house. Somehow this education is not made use of by the people where it is available, while it must be added that the community level service is not available in all the villages. In the research village no shops nor the houses have been visited by a P.H.I. for the last seven years. Unavailability of suitable transport to reach remote areas is given as one of the reasons for this lapse. Hence monitoring and supervision of public health precautions in peripheral areas seem to get neglected.

Nowadays much discussion has been e.g. in the press about the health supervision. I citate here one article by Edward Arambawela (in Sunday Observer 3.10.1982):

"Health Supervision Lacking

There is unsatisfactory supervision throughout the government's health care system today. This has been identified by the Health Department

as one of the major weaknesses in the present health care services.
The other weaknesses pinpointed are:
(a) Development of an imbalance between the curative and preventive services with the latter receiving inadequate resources
(b) Contacts between preventive and curative staff are few
(c) Services unevenly distributed
(d) and rapidly rising costs of curative care for preventable diseases
Now the new health reorganization scheme with Gramodaya Health Centres at the bottom and the Family Health Workers being given an important role to play in community health had been evolved these weaknesses."

The whole primary health care system is under reform (see Annex 13). The difference between the old and new system will be that the latter one is more prevention-oriented. By the year 1991 there will be 3893 Gramodaya Health Centres each with one Family Health Worker. In the research area there will be 54 centres.

There is, however, something regarding waste disposal that Western people could learn from Sri Lankans. A general philosophy that anything which is usable should not be wasted is evident all over the country. This reduces the amount of wastes like papers, tins, glasswares etc.

6.3. Use of Chemicals on Cultivation - Effects on Water

Pesticides and fertilizers are widely used on paddy and vegetable cultivations in Sri Lanka. Very dangerous chemicals that are banned in other countries are used in Sri Lanka as pesticides. According to World Health Organization (1982) five out of every 1000 of the agricultural workers are

hospitalised annually for pesticide poisoning in Sri Lanka[1] - the total number of poisonings must be higher.

The amount of pesticides used in the research area, however, is quite small when compared with many other areas in Sri Lanka. Here the land under paddy is quite small - they can control the destructive insects without large amounts of poisons. Anyway, the use of chemicals is not beyond consideration in a study of water of the area - especially because the wells are usually uncovered and are situated on paddy tracts. According to some villagers the water that comes from hills is even more polluted because much more agrochemicals and fertilizers are used in the vegetable and banana cultivation on the high lands.[2]

In the research village fertilizers are used regularly while pesticides are used only when needed - usually against worms (pesticides mentioned by villagers are kuretha, tamaron, DDT and malation).

Some people clean their wells after spraying pesticides on the paddy field (where the well is situated). Some of the villagers do not use the well for a couple of days, they think that the water becomes clean during this time!

Pesticides are available to anyone in Sri Lanka. That is why there are also so much misuse of them. More research should be done about the effects of these chemicals on the water.

---

[1] The death rate of pesticide poisoning in Sri Lanka is the highest in the world. 73 % of all the poisonings are suicidal - occupational and accidental poisonings 24.9 % (WHO, 1982 - citated by "Weekend" 21.11.1982).

[2] According to Morrison, Moore and Lebbe (1979): "Compared to paddy, vegetable cultivation involves more agro-chemicals and fertilizers and is therefore much more capital intensive."

6.4. Sanitation Plans of the Finnish Project

The present Sri Lankan government pays Rs. 250 (~12.5 US $) per family to construct a latrine. The amount of this aid is, however, limited and only a few new latrines are built in one village per year.

There is really a need of new toilets in the villages and towns of the area - and not only for individual households but also common latrines.

The Finnish government - it is hoped - will give aid for the construction of new latrines in villages of our research area. The Finnish Project will supply pit lining materials, cover slabs and material for 1 m walls for villagers. Villagers will construct the latrines by themselves. They also can decide by themselves what kind of latrine they like to have, dry pit latrine or water sealed.

The Firm has now chosen three different kinds of latrines for testing. One of each type is under construction so far (test latrines). The three types are:

(1) Pour flush toilet; offset double pit design. This is a latrine with two pits, first one is used for 2...3 years and after that another pit is taken into use. One year after this the first pit is supposed to be emptied. This type has been chosen to one test latrine because in densely populated town areas there is no space available always to dig new pits. The test latrine of this type will be attached to the house.

(2) Pour flush toilet; direct discharge design. Simply wet type latrine with water trap. The materials for this kind of latrine will also include a cleaning brush and a flushing jug (volume 2 liters).

(3) Ventilated improved pit latrine. This is a dry variation of the above-mentioned (no. 2) toilet. This dry type is equipped with ventilation pipe which decreases the occurrence of flies and mosquitos.

Next step by the Firm is to give material for 20...30

test latrines of above-mentioned types. In addition to this at least one common latrine will be constructed. Further plans will be made on the knowledge and experience that would spin off from these initial projects.

7. CONCLUSIONS

There is a problem with diarrhoeal diseases, as well as some other diseases in the research area. These diseases are due to poor sanitation, lack of health education and of an adequate water supply. An attempt is being made to provide an adequate drinking water supply to villagers from new hand pump wells. However, there have been some problems with the quality of water and the use of these wells.

The analysis of water in the traditional wells of the village and the new hand pump wells show that physical and chemical quality of water in the traditional wells is better than in the new wells. (Water in the latter wells is inferior in colour - a.o. due to iron - hardness and conductivity. It also contains more carbon dioxide, ammonium, iron and silica and shows a higher rate of $KMnO_4$ consumption.)

The bacterial quality, on the contrary, is better in the new wells, even though they, too, have shown instances of bacterial pollution. This, however, is not an aspect noticed by the villagers. Water from two or three new wells that are considered to be very good by the villagers were found to be full of bacteria on analysis. On the other hand the slightest obvious yellow colour caused by iron has caused the abandonment of a well and return back to the old wells.

During the research period there were no real dry seasons and therefore it was not possible to observe the effect of draught on the use of new hand pump wells, when some of the old wells get dry.

With the completely covered new hand pump wells one major problem can be averted - viz. the access of rain water into wells, which is a very big health hazard in the area. Many of the water-related diseases are caused due to the free flow of rain water into wells.

As can be seen in the report, there is a need for a

better water supply even in the hospitals of the research area. In these very places - which are expected to build up the health of the people - the supervising and maintenance of good water quality is completely neglected.

There is a lack of bathing wells with pure water also in the area. The villagers are very keen to upgrade their own wells (instead of constructing a new one at another place). The Finnish experts do not favour to construct new hand pump wells at the same sites of old well. Therefore it would be possible to construct new bathing wells at the sites of old drinking wells.

The Finnish Project also includes a sanitation programme where material for toilets are provided to the villagers. In this project, problems will arise if the suitable type of latrine is not chosen. Water seal latrines are good and clean - when there is an adequate water supply. If not, it would be better to construct pit latrines.

Another point that must be taken into consideration with latrines is that in the rural areas, at least, latrines with tanks which need to be emptied may not be so popular, simply because the people are still averse to the idea of emptying a septic tank themselves. Hired labour for the purpose may not be within their economic circumstances.

There is a need for common toilets, too, in the area. If and when providing these to villages, a caretaker (like with wells) should be appointed to supervise these latrines.

When carrying out this kind of water and sanitation programmes, attention must be paid to health education, too. It is necessary to explain to the people the need for safe water and what pure water is and how and in which situations water can get polluted. People seem to understand the importance of water (quantity) but do not always know what kind of water is safe (quality).

It is not effective if the health educator comes from bigger towns just to give a lecture and show films to villagers. Often this kind of person does not speak the language of the villagers. It would be better to get villagers to

participate in this type of work. A good organization to work through with this kind of programme could be Sarvodaya, and the Gramodaya Mandalas.

The lack of following and supervising the health regulations (which are quite strict) seems to be a problem in Sri Lanka (a.o. due to shortage of trained personnel). Some improvement to the situation can be expected with the new primary health care system with which more midwives (Family Health Workers) and Public Health Inspectors will be engaged. After that, perhaps, more health education could also be given through them.

The water analysis will be a very important part regarding the maintenance of the new hand pump wells in the future. It would also be good to conduct more extensive analyses instead of only the routine ones (which were the only possibilities during the research period). Some aid, perhaps, for this kind of activities should be given.

We, as researchers, have been some kind of a link between the villagers and the Finnish Consultant Firm during the research period. The Finnish consults have been informed about the problems regarding the new wells, as well as new sanitation plans. Some points seem to be taken into consideration by them.

The villagers, too, have been informed about consultants' plans and whom and how to contact in case of problems regarding the new wells. We have also encouraged villagers to voluntary work (and not just wait for everything to be provided for them) and to co-operate with each other; for example to help when latrine materials are provided to villagers living far away from the road (usually the poorest people) who need help to get the material carried to their houses. Further, poor people cannot afford to pay for masons. Here Shramadana work among villagers would be needed.

When continuing this research and when carrying out other research projects of this type it is essential not only to conduct water analysis programmes but also geological tests and surveys.

References

AGARWAL, Anil, KIMONDO, James, MORENO, Glorie and TINKER, Jon, 1981: Water, Sanitation, Health - for All? Prospects for the International Drinking Water Supply and Sanitation Decade, 1981-90. International Institute for Environment and Development. London 1981.

FEACHEM, Richar, McCARRY, Michael and MARA, Duncan, 1978: Water, Wastes and Health in Hot Climates. John Wiley & Sons. 1978.

FLICK-LAGERWEY, J. and ANTHONPILLAI, 1982: A Study into the Use of Toilet Facilities on the Estates. IRDP Office, Nuwara Eliya, Sri Lanka, June 1982.

JAYAWEERA, D.M.A., 1982: Medicinal Plants Used in Ceylon. Parts 1...4. National Science Council of Sri Lanka. Colombo 1982.

KAMPSAX-KRÜGER, 1982: Technical, Sociological and Financial Report; Matale and Polonaruwa, January 1982.

KELLES-VIITANEN, Anita, 1982: Water and Wells, Symbols of Prestige, Power and Prosperity in a Sinhalese Village. A Study made for Harispattuwa Water Development Programme "Water and Society". Kandy, December 1982.

MINISTRY OF HEALTH, 1980: Annual Health Bulletin 1980. Ministry of Health - Sri Lanka.

MINISTRY OF HEALTH, 1981: Improvements to Health Care Delivery System. Ministry of Health - Sri Lanka. December 1981.

MINISTRY OF LOCAL GOVERNMENT, HOUSING AND CONSTRUCTION, 1980: Draft Plan for the International Drinking Water Supply and Sanitation Decade (1981-1990).

MORRISON, Barrie M., MOORE, M.P. and LEBBE ISHAK M.V., 1979: The Disintegrating Village. Social Change in Rural Sri Lanka. Colombo 1979.

WORLD HEALTH ORGANIZATION, 1971: International Standards for Drinking Water.

Annex 1. Data about study village

Total population

	No. of families	Males	Females	Total
No. of persons	168	404	460	864
%		46.76	53.24	100

Population according to age groups

	Age groups							
Sex	0-5	6-14	15-19	20-40	41-55	56-65	65 and above	Total
Male	52	89	42	126	58	23	14	404
Female	63	95	45	141	70	22	24	464

Cast distribution

	Bodiwansa	Drummer	Total
No. of persons	810	54	864
%	93.75	6.25	100

Educational level of the respondents

Description	No. of persons	%
1. Illiterate	240	27.78
2. Grade 1-5	300	34.72
3. Grade 6-10 (S.S.C./G.C.E. o/l)	298	34.49
4. H.S.C./G.C.E. (a/l)	22	2.55
5. University degree	4	0.46
6. Technical/training	-	-
7. Other	-	-
Total	864	100.0

Marital status

	Never married	Married	Divorce	Widow	Total
No. of persons	504	306	1	53	864
%	58.33	35.42	0.11	6.14	100

Location of marriage

	Nuclear	Deega	Binna	Total
No. of families	145	28	3	176
%	82.39	15.91	1.7	100

Main economic activities - non-agriculture (no. of persons)

Total	Wage labour-er	Govt. occu-pation	Non govt.	Trader	Self-em-ployed	Skilled labour-er	Un-skill-ed la-bourer	Other
140	57	16	10	22	10	16	7	2

Main economic activities - agriculture

	Total	Owner-non cultiva-tor	Owner cultiva-tor	Tenant cultiva-tor	Wage labourer
No. of persons	161	30	63	57	11

Income groups according to main activities - agriculture

	Less than 1000	1000-1999	2000-2999	3000-3999	4000-4999	5000-9999	10000-19999	20000 and above	Total
No. of families	37	36	18	9	6	7	6	1	120
Total income (Rs.)	22810	50490	42140	30140	25700	55940	66400	27688	

Income groups according to main activities - non-agriculture

	Less than 1000	1000-1999	2000-2999	3000-3999	4000-4999	5000-9999	10000-19999	20000 and above	Total
No. of families	5	16	17	13	5	35	10	6	107
Total income (Rs.)	2700	23500	39000	42960	24000	235130	125980	175516	

Subisidiary economic activities

	Total	Wage labourer	Trader	Self-employment	Others
No. of persons	29	19	5	3	2

Income groups according to subsidiary economic activities

	Less than 1000	1000-1999	2000-2999	3000-3999	4000-4999	5000-9999	10000-19999	20000 and above	Total
No. of families	6	5	11	1	-	3	-	-	26
Total income (Rs.)	2200	6500	26168	3600	-	19400	-	-	

Ownership of radio & tv

	Radio	Tv	Radio & tv	No radio or tv	Total
No. of families	116	2	2	49	169
%	68.64	1.18	1.18	29.0	100

Size of house garden and other highlands (owned)

Size classes ac.	House garden		Other highlands	
	No. of families	Acres	No. of families	Acres
Less than 0.25	30	4.93	5	0.675
0.25-0.49	58	18.0	12	3.0
0.5-0.99	49	26.9	10	6.0
1.0-1.99	24	26.5	11	15.5
2.0-2.99	6	12.8	3	6.25
3.0-3.99	-	-	6	19.0
4.0-4.99	-	-	3	12.25
5.0 and above	-	-	5	45.0
Total	167	89.13	55	107.675

Size of paddy land holdings

Size classes ac.	Owned		Tenant & rent	
	No. of families	Acres	No. of families	Acres
Less than 0.25	14	1.68	3	0.3
0.25-0.49	25	6.56	10	2.5
0.5-0.99	22	12.75	23	14.5
1.0-1.99	11	13.2	5	5.0
2.0-2.99	3	6.0	-	-
3.0-3.99	1	3.0	-	-
4.0-4.99	-	-	1	4.0
5.0 and above	2	12.0	-	-
Total	78	55.19	42	26.3

Distribution of total annual income

Income groups (Rs.)	No. of families	Total income (Rs.)
Less than 1000	-	-
1000-1999	1	1674
2000-2999	12	29879
3000-3999	10	39180
4000-4999	28	126304
5000-9999	74	514598
10000-19999	30	421014
20000-49999	11	421434
50000 and above	2	186600

Bathing & drinking water sources

	Pipe private	Well	Spring	Total
Drinking:				
No. of families	1	151	16	168
%	0.6	89.88	9.52	100
Bathing & washing:				
No. of families	1	135	32	168
%	0.6	80.36	19.04	100

Source of information: Census made by the University of Peradeniya

Annex 2. Home interviews

Age distribution	Male	Female	Total
0-9	-	-	-
10-19	-	-	-
20-29	1	3	4
30-39	4	3	7
40-49	3	5	8
50-59	2	2	4
60-69	2	1	3
70 and above	3	2	5
Total	15	16	31

Education	No. of persons
1. Illiterate	6
2. Grade 1-5	9
3. Grade 6-10	15
4. Advanced level	1
5. University	-
6. Training	-
Total	31

Size distribution	Highland		Lowland	
	No. of persons	Acres	No. of persons	Acres
Less than 0.25	-	-	-	-
0.25-0.49	7	1.75	6	1.5
0.5-0.99	7	3.75	3	1.75
1.0-1.99	1	1.0	1	1.75
2.0-2.99	2	4.0	-	-
3.0-3.99	-	-	-	-
4.0-4.99	-	-	-	-
5.0 and above	-	-	-	-
Total	17	10.5	10	5.0

Occupation	No. of persons
1. Owner non cultivator	2
2. Owner cultivator	8
3. Wage labourer	1
4. Business	3
5. Tenant cultivator	3
6. Owner non cultivator & business	2
7. Owner cultivator & business	3
8. Owner cultivator & carpentry	2
9. Tenant cultivator & wage labourer	4
10. Tenant cultivator & business	1
11. Others	2
Total	31

Annex 3. Special interviews

Age distribution	Male	Female	Total
0-9	-	-	-
10-19	1	-	1
20-29	2	-	2
30-39	1	1	2
40-49	-	3	3
50-59	1	1	2
60-69	2	-	2
70 and above	-	-	-
Total	7	5	12

Education	No. of persons
1. Illiterate	2
2. Grade 1-5	1
3. Grade 6-10	5
4. Advanced level	3
5. University	-
6. Training	1
Total	12

Size distribution	High land		Low land	
	No. of persons	Acres	No. of persons	Acres
Less than 0.25	-	-	-	-
0.25-0.49	1	0.25	2	0.5
0.5-0.99	1	0.5	2	1.25
1.0-1.99	1	1.0	-	-
2.0-2.99	3	6.75	1	2.0
3.0-3.99	-	-	-	-
4.0-4.99	1	4.5	-	-
5.0 and above	1	7.25	-	-
Total	8	20.25	5	3.75

Occupation	No. of persons
1. Owner cultivator	2
2. High land cultivator	1
3. Owner non-cultivator & business	1
4. Nurse	1
5. Midwife	1
6. Traditional midwife	1
7. Teacher	1
8. Sarvodaya & owner cultivator	1
9. Clergy	2
10. Gramasevaka	1
Total	12

Annex 4. Topics of the village interviews

Drinking water
- source, opinions about it
- use of the water - do they boil it

Bathing
- place - opinions
- use of soap

Washing and drying of clothes

Personal hygiene

Latrines
- type, location, opinions
- what happens when it gets full

Waste disposal

Food preparing

Health situation of the family/village
- occurrance of water and fecal related diseases

Annex 5. Organizations and institutions interviews

Ministry of Local Government, Housing and Construction, Colombo
- Senior assistant secretary

National Water Supply and Drainage Board, Ratmalana
- Assistant general manager

Water Resources Board
- 2 engineers

Unicef Office, Colombo
- Chief of water and sanitation section
- 2 project officers

Women's Bureau, Colombo
- Assistant director

Health Education Bureau, Colombo
- Health education specialist

Agrarian Service Department
- Divisional officer
- Cultivation officer

Sarvodaya Kandy District Center
- Sarvodaya worker

Assistant Government Agent
- Acting assistant government agent
- Assistant government agent

Health Department
- Superintendent of Health, Kandy
- Medical Officer of Health, Harispattuwa
- Public Health Inspector, Ankumbura

Hospitals of the research area
- doctors and other staff

Annex 6. Schoolchildren's questionnaire

1. What kind of water is good?

2. (a) From where do you get water to your home?
   (b) Do you think that water is clean?

3. (a) From where do you get water to your school?
   (b) Do you think that water is clean?

4. (a) Do you boil your drinking water at home - when?
   (b) Who uses hot water in your home - who does not?
   (c) Do you think it is necessary to boil water?

5. What do you think is the most suitable type of toilet?
   (pit latrine - bucket latrine - water seal toilet)

6. (a) What type of latrine do you have at home?
   (b) Do you think that type is suitable? Give reasons.

7. (a) What kind of latrine do you have in your school?
   (b) Do you think that type is suitable? Give reasons.

8. (a) From where do you get water to the latrine at your home?
   (b) What kind of utensil do you use to fetch that water?

9. (a) From where do you get water to your school latrine?
   (b) What kind of utensil do you use to fetch that water?

10. (a) How many times do you wash your hands during a day? What are these times?
    (b) How do you have your morning washing and where?

11. (a) Where do you dump the garbage at home/in the school?
    (b) Do you think that place is suitable? Give reasons.

12. (a) What kind of food do you eat during school day?
    (b) Do you think that food is nourishing?

13. Who advices you about nourishing food? (doctor - parents - teachers)

14. (a) How many times did you have diarrhoea last year?
    (b) Do you know how diarrhoea can be spread?

15. How many times per week do you bathe?

16. Do you have any special days when you don't bathe? What are these days?

17. Who gives you advice on water hygiene? (teachers - doctors - parents - radio - tv)

18. (a) Do you know what diseases can spread by water?
    (b) How we can avoid these diseases?

19. What do you do if you get an attack of diarrhoea?

Annex 7. Answers given in the schoolchildren's questionnaire

1. Answers about "good water"

Description	Dola-pihilla-gama	Ugu-ressa-piriya	Total
1. Boiled water	10	0	10
2. Clean water	13	17	30
3. Beautiful water	4	0	4
4. Well pipe water	1	2	3
5. Nonsensical answers (e.g. "dirty water")	0	8	8
6. No response	4	3	7
Total	32	30	62

2a. "Source of water" at home

Description	D.	U.	Total
1. Well water	24	26	50
2. Pipe water	2	0	2
3. Stream/spout/river water	1	0	1
4. Tank water	1	0	1
5. Stream/well	1	2	3
6. Pipe/well	0	1	1
7. No response	3	1	4
Total	32	30	62

2b. "Is that water clean"

Answer	D.	U.	Total
1. Yes	22	12	34
2. No	2	1	3
3. Boiled water is clean	1	3	4
4. Clean and unclean	2	4	6
5. No response	5	10	15
Total	32	30	62

3a. From where do you get water to your school?

Source	D.	U.	Total
1. Well	21	17	38
2. Pipes	0	8	8
3. School well	5	0	5
4. Bring it by buckets	4	0	4
5. No response	2	5	7
Total	32	30	62

3b. Do you think that water is clean?

Answer	D.	U.	Total
1. Yes	17	11	28
2. No	1	5	6
3. Put medicine	0	3	3
4. Boiled water (we drink)	0	1	1
5. Well broken (dirty water gets inside)	3	2	5
6. No response	11	8	19
Total	32	30	62

4a. Do you boil you drinking water - when?

Answer	D.	U.	Total
1. Before meals (three times)	8	0	8
2. After meals	4	0	4
3. Yes	2	5	7
4. No	0	2	2
5. We use it for everything	8	15	23
6. When it rains (dirty water)	3	1	4
7. When we have sickness	1	2	3
8. Our water is clean	1	1	2
9. No response	5	4	9
Total	32	30	62

4b. Who uses hot water at your home?

Answer	D.	U.	Total
1. Whole family	20	13	33
2. Part of the family	2	8	10
3. Sick and/or old people	1	1	2
4. Yes	0	2	2
5. Nobody	1	3	4
6. No response	8	3	11
Total	32	30	62

4c. Do you think it is necessary to boil water?

Answer	D.	U.	Total
1. Boiled water is good	5	6	11
2. If we don't boil we can get sick	9	5	14
3. Boiled water is clean (killed the germs)	8	6	14
4. Yes	3	2	5
5. Don't think so	0	1	1
6. No response	7	10	17
Total	32	30	62

5. Which toilet is the most suitable?

Answer	D.	U.	Total
1. Pit toilet	11	19	30
2. Bucket toilet	5	5	10
3. Water seal	5	1	6
4. No response	11	5	16
Total	32	30	62

6a. What type of a latrine do you have at your home?

Answer	D.	U.	Total
1. Pit toilet	12	19	31
2. Water seal	10	2	12
3. Mud toilet	1	1	2
4. Concrete toilet	1	0	1
5. Bucket toilet	2	0	2
6. Clean toilet	2	2	4
7. Closed all sides	1	0	1
8. No response	3	6	9
Total	32	30	62

6b. Do you think that type is suitable?

Answer	D.	U.	Total
1. Yes	0	3	3
2. No	0	3	3
3. Pit toilet is good (doesn't smell, clean, doesn't want more water)	10	13	33
4. Water seal latrines are clean (don't have smell)	7	1	8
5. Pit toilet is not suitable (smell)	2	2	4
6. Bucket toilet hasn't smell	2	0	2
7. No response	11	8	19
Total	32	30	62

7a. What type of latrine do you have in your school?

Answer	D.	U.	Total
1. Pot toilet	18	18	36
2. Water seal toilet	4	3	7
3. Bucket toilet	1	0	1
4. Concrete toilet	2	2	4
5. Clean toilet	1	1	2
6. Many kinds of toilets (urinate and toilet)	2	1	3
7. No response	4	5	9
Total	32	30	62

7b. Do you think that type is suitable - reasons

Answer	D.	U.	Total
1. Yes it is good	7	8	15
2. Clean and best toilet	7	2	9
3. No	2	3	5
4. It doesn't smell and can be used for long time	2	2	4
5. No response	14	15	29
Total	32	30	62

8a. From where do you get water to the toilet at your home?

Answer	D.	U.	Total
1. Common well (public)	13	8	21
2. Private well	6	4	10
3. Drinking well	5	2	7
4. Bathing well	1	5	6
5. Separate wells	0	2	2
6. Pit (through a pit)/ old well	3	2	5
7. No response	4	7	11
Total	32	30	62

8b. What type of a utensil do you use to fetch that water

Answer	D.	U.	Total
1. Bucket	14	4	18
2. Tin	10	3	13
3. Pot	2	9	11
4. Clean utensil	1	2	3
5. Any kind of utensil	1	2	3
6. No response	4	10	14
Total	32	30	62

9a. From where do you get water to your school latrine?

Answer	D.	U.	Total
1. Drinking well	0	7	7
2. Bathing well	26	8	34
3. Pipe	0	4	4
4. Government well	0	3	3
5. No response	6	8	14
Total	32	30	62

9b. What type of utensil do you use in school to fetch water?

Answer	D.	U.	Total
1. Bucket	14	2	16
2. Tin	7	7	14
3. Pot	3	4	7
4. Clean utensil	2	2	4
5. No response	6	15	21
Total	32	30	62

10a. How many times do you wash your hands for a day and what times?

Answer	D.	U.	Total
1. Two times (after toilet)	2	1	3
2. Three times (when eating three times)	16	19	35
3. Four times (before eating and after toilet)	2	0	2
4. Five times (before eating and after toilet)	3	2	5
5. Six times (before eating and after toilet)	0	1	1
6. More than seven times	3	1	4
7. No response	6	6	12
Total	32	30	62

10b. How do you have your morning washing and where?

Answer	D.	U.	Total
1. Near the well	8	2	10
2. At home	2	0	2
3. Wash the face	5	5	10
4. Inside the toilets	3	0	3
5. Wash with soap	2	1	3
6. Whole body	1	1	2
7. No response	11	21	32
Total	32	30	62

11a. At home and in school where do you dump the garbage?

Answer	D.	U.	Total
1. Filth pit	21	14	35
2. Into garden	5	4	9
3. Into stream	1	0	1
4. Dust bins	0	2	2
5. No response	5	10	15
Total	32	30	62

11b. Do you think that place for garbage is good? Reasons

Answer	D.	U.	Total
1. Yes, good	3	1	4
2. Because we can use manure	9	0	9
3. Filth pit far from the school	3	0	3
4. Set fire to it	2	1	3
5. We put them in stream	0	1	1
6. If we put everywhere we can get disease	6	0	6
7. No response	9	27	36
Total	32	30	62

12a. What type of food do you eat during school time?

Answer	D.	U.	Total
1. Hoppers & string hoppers	0	7	7
2. Biscuits	9	4	13
3. Bread	5	2	7
4. Sweets	2	2	4
5. Fruits	1	3	4
6. Many different kinds of foods	6	2	8
7. Rice	3	1	4
8. None	2	2	4
9. No response	4	8	12
Total	32	30	62

12b. Do you think that this food is nourishing?

Answer	D.	U.	Total
1. Yes	16	6	22
2. No	3	7	10
3. Perhaps	2	0	2
4. We get vitamin food	2	7	9
5. No response	9	10	19
Total	32	30	62

13. Who advices you about nourishing food?

Answer	D.	U.	Total
1. Doctors	5	0	5
2. Teachers	8	15	23
3. Parents	1	1	2
4. Doctors & teachers	2	0	2
5. Doctors & parents	1	0	1
6. They all (doctors, teachers, parents)	1	5	6
7. Yes	3	1	4
8. No	1	1	2
9. No response	10	7	17
Total	32	30	62

14a. How many times did you have diarrhoea last year?

Answer	D.	U.	Total
1. Never	6	13	19
2. One	3	0	3
3. Two	1	0	1
4. Three	3	0	3
5. Four	0	0	0
6. Five	1	0	1
7. Difficult to say	1	0	1
8. I didn't get last year	7	9	16
9. No response	10	8	18
Total	32	30	62

14b. Do you know how diarrhoea can be spread?

Answer	D.	U.	Total
1. Yes	3	1	4
2. Through water	2	11	13
3. Because of bacteria	7	1	8
4. From another person	1	1	2
5. From mosquitoes	1	1	3
6. From unclean toilets	0	1	1
7. Unclean food	4	0	4
8. From cow dung	1	0	1
9. Germs entering through wounds	3	0	3
10. No response	20	14	24
Total	32	30	62

15. How many days per week do you bathe?

Answer	D.	U.	Total
1. Once a week	1	2	3
2. Twice a week	2	7	9
3. Thrice a week	8	6	14
4. Four times a week	10	3	13
5. Five times a week	1	2	3
6. Six times a week	1	2	3
7. Every day	1	2	3
8. Every other day	3	1	4
9. No response	5	5	10
Total	32	30	62

16. Do you have any special days you don't bathe? What days? Do you have a body bath these days?

Answer	D.	U.	Total
1. Tuesday	5	4	9
2. Tuesday & Wednesday	3	1	4
3. Tuesday & Thursday & Saturday	3	3	6
4. Monday & Wednesday	1	-	1
5. Sunday	1	1	2
6. Monday & Friday	2	2	4
7. Friday	1	1	2
8. No special days	4	1	5
9. Other answers	9	5	15
10. No response	3	11	14
Total			

17. Who gives advice on water hygiene?

Answer	D.	U.	Total
1. Teachers	7	13	20
2. Doctors	4	0	4
3. Parents	1	2	3
4. Radio	3	0	3
5. Tv	3	0	3
6. Radio & tv	1	0	1
7. Parents & teachers	0	1	1
8. Teachers & doctors	2	1	3
9. They all	6	2	8
10. No response	8	9	17
Total	32	30	62

18a. What diseases spread from water?

Answer	D.	U.	Total
1. Diarrhoea	1	1	2
2. Cholera	7	0	7
3. Diarrhoea & stomach ache & cholera	1	7	8
4. Cold & fever	4	4	8
5. Diarrhoea, typhoid & cough	1	1	2
6. Cholera, tetanus & smallpox	2	0	2
7. Cholera & malaria	4	2	6
8. Other diseases (tonsils, heart diseases, rash)	6	4	10
9. No response	6	11	17
Total	32	30	62

18b. How to avoid these diseases

Answer	D.	U.	Total
1. Spoiled food don't eat, boiled water drink, dirty put in a pit	2	-	2
2. By taking medicine you can prevent	0	4	4
3. Go to the doctor	12	7	19
4. Boiled water drink	6	4	10
5. Other answers	5	1	6
6. No response	7	14	11
Total	32	30	62

19. What do you do if you are attacked by diarrhoea?

Answer	D.	U.	Total
1. Take medicine	21	7	28
2. People who get diarrhoea should be separated	0	2	2
3. To be cleaned and to eat clean food	1	1	2
4. To wash hands and legs	1	0	1
5. No response	9	20	29
Total	32	30	62

Annex 8. Details of hospitals in the Harispattuwa administration

Details	Ankumbura	Akurana	Medawala	Katugas-tota	Thittapajjala
Type of hospital*	D.H.	P.U.	P.U.	P.U.	R.H./M.H.
Wards: Male/Female/ Maternity home/ children	$M^2/F^2/$ $M.H^1$	$M.H.^1$	$M^1/F^1_1/$ $M.H.^1$	$M^1/F^1_1/$ $M.H.^1$	$M^1/F^1_1/$ $M.H.^1$ (still not open children)
Number of beds	82	18	36	40	27
Staff**					
-Medical officers	1	2	2	1	1
-Assistant medical practitioner/ Registered medical practitioner	RMP^1_1 RMP^1	$AMP^1_1/$ RMP^1	AMP^1	AMP^1_1 RMP^1	RMP^1
Nurses	5	5	-	2	-
Midwives	2	3	3	3	2
Attendants***	m4 f5	m2 f4	m3 f2	m2 f5	m3 f5
Labourers: sanitation	m5 f-	m7 f-	m2 f-	m3 f-	m3 f-
ordinary	m5 f8	m2 f2	m2 f-	m5 f1	m2 f1
Others: dispensers/malaria blood overseers/ pump operators	DIS/MBO	_	DIS	DIS/MBO	DIS/MBO
Facilities					
-Water/electricity	w/e	w/e	w/e	w/e	w/e
-Ambulance	1	1	1	-	1
-Mortuary	1	1	1	1	1
-Labour-rooms	1	1	1	1	1
-Latrines: bucket			2		
-Latrines: water seal	15	3	4	9	3
Bathing rooms	yes	yes	yes	yes	yes
Visit day/time	17/8 4.30 pm	16/6 1.00 pm	19/8 3.00 pm	23/8 12.14 pm	29/8 2.00 pm
Number of out-patients on the visit day	300	350	250	350	200
Number of inp-patients on the visit day	15	5	4	2	5

(cont.)

Details	Bokkawela	Puja-pitiya	Alawa-tugoda	Giri-hagama	Bokkawela Morankanda
Type of hospital*	C.D./M.H.	C.D.	Only mothers childrens clinic	C.D.	"FRIDSRO" medical centre
Wards: Male/female/ Maternity home/ children	M.H.[1]	-	-	-	M[1]/F[1]/M.H
Number of beds	12	1	1	1	40
Staff**					
-Medical officers	-	-	-	-	2
-Assistant medical practitioner/ Registered medical practitioner	RMP[1]	RMP[1]	-	RMP[1]	-
Nurses	-	-	-	-	8
Midwives	1	-	-	-	-
Attendants***	m- f1	-	field nurses	field nurses	-
Labourers: sanitation	m2 f-	-	m- f-	m- f-	ml f-
ordinary	ml f3	-	ml f-	ml f-	ml f-
Others: dispensers/malaria blood overseers/ pump operators	DIS/MBO/ PO	DIS	-	DIS	DIS/Mbo
Facilities					
-Water/electricity	w/e	w/e	-	w/e	w/e
-Ambulance	-	-	-	-	-
-Mortuary	-	-	-	-	1
-Labour-rooms	1	-	-	-	1
-Latrines: bucket	-	-	-	-	-
-Latrines: water seal	7	2	ws	ws	ws
Bathing rooms	yes	no	no	no	yes
Visit day/time	18/8 1.00 pm	-	-	-	6/9 11.00 am
Number of out-patients on the visit day	80	25	200	70	25
Number of in-patients on the visit day	4	-	-	-	1

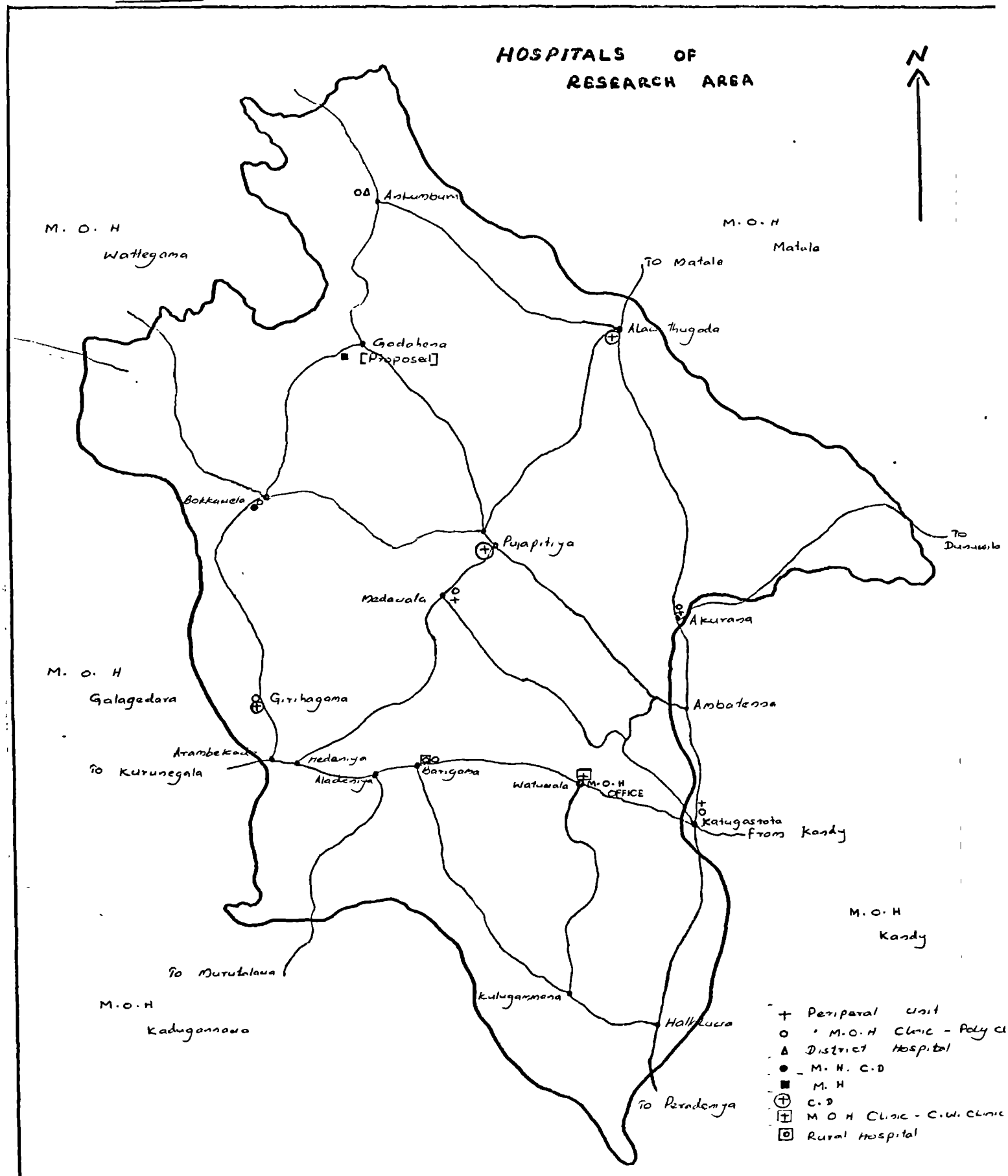
(cont.)

* P.U. = Peripheral unit
  D.H. = District hospital
  R.H. = Rural hospital
  C.D. = Central dispensary
  M.H. = Maternity home

** In addition to this medical personnel there are 9 public health inspectors (P.H.I.), 33 public health midwives (P.H.M.; 21 vacancies), 3 public health nurses (P.H.N.) and one public health instructor (tutor/P.H.) in the area

*** m = male; f = female

Annex 9.


HOSPITALS OF RESEARCH AREA
N
Ankumbura
M. O. H
Wattegama
M. O. H
Matala
To Matale
Alawathugoda
Godahena
[Proposed]
Bokkawela
Pujapitiya
To Dunuwila
Madawala
Akurana
M. O. H
Galagedara
Giriagama
Ambatenna
Arambekanda
To Kurunegala
Hedaniya
Aladeniya
Barigama
Watawala
M.O.H OFFICE
Katugastota
From Kandy
M. O. H
Kandy
To Mututalawa
M.O.H
Kadugannawa
Kulugammana
Hallukura
To Peradeniya
Peripheral Unit
M.O.H Clinic - Poly Cl
District Hospital
M. H. C.D
M. H
C.D
M O H Clinic - C.W. Clinic
Rural Hospital

Annex 10. Hospital system in Sri Lanka

1. Postgraduate Teaching Hospital
   - 1 in whole country
   - Colombo general hospital

2. Teaching hospitals
   - 4 in whole country
   - one in Peradeniya

3. General hospitals (G.H.)
   - 1 for province
   - all specialities

4. Base hospitals (B.H.)
   - 1 for district (not in Kandy district because there is general hospital)
   - only 4 specialities (gynecology, pediatria, E.N.T., eye)

5. District hospital (D.H.)
   - about 60 beds
   - no specialities

6. Peripheral units (P.U.)
   - about 40 beds
   - maternal, male and female wards (no children)

7. Rural hospitals (R.H.)
   - there is one medical officer

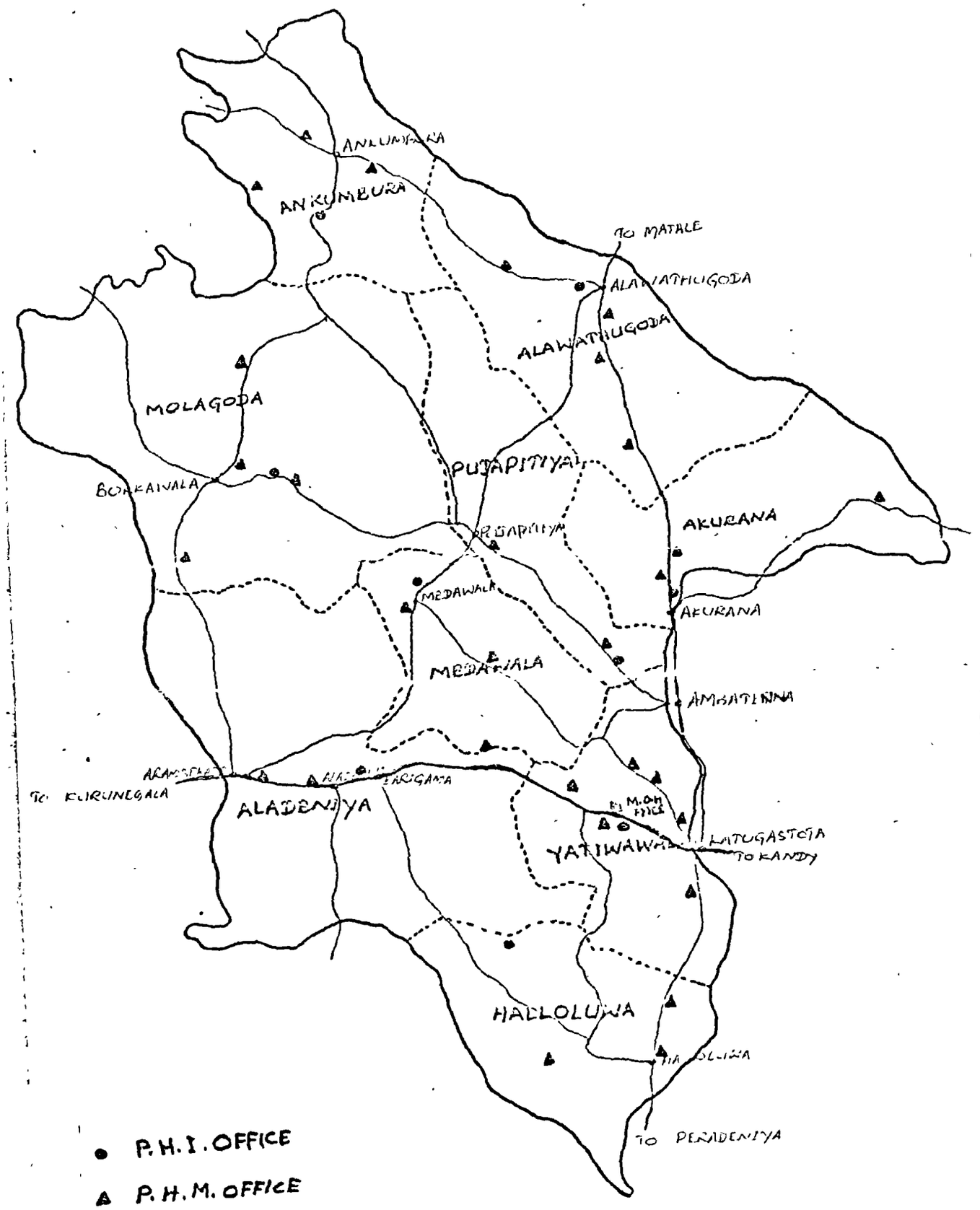
8. Central Dispensary and Maternity Home (C.D./M.H.)
   - only maternity ward
   - no (other) inpatients

9. Central Dispensary (C.D.)
   - only outpatients

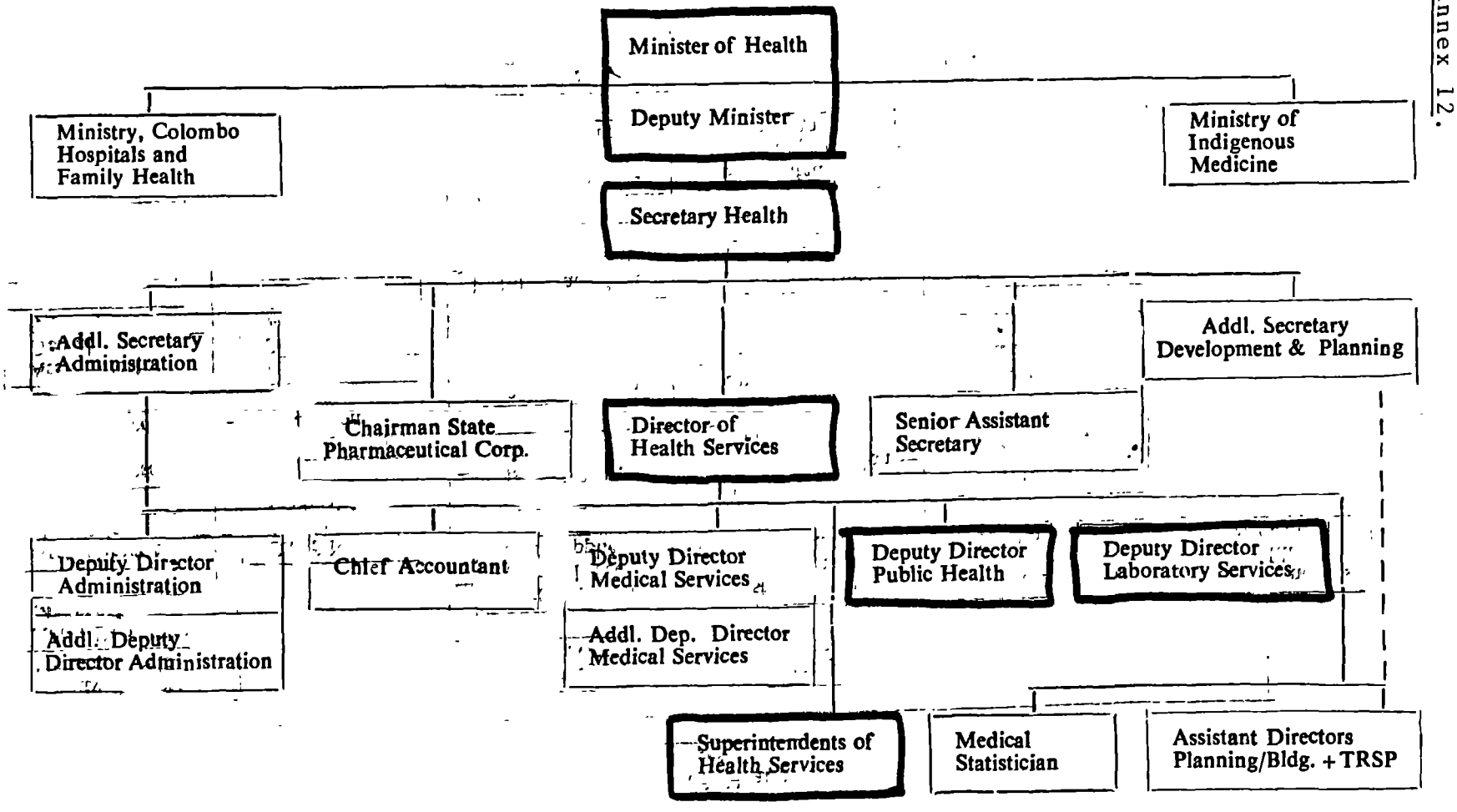
10. Maternity home

Annex 11.

AREAS OF PUBLIC HEALTH INSPECTORS IN RESEARCH AREA



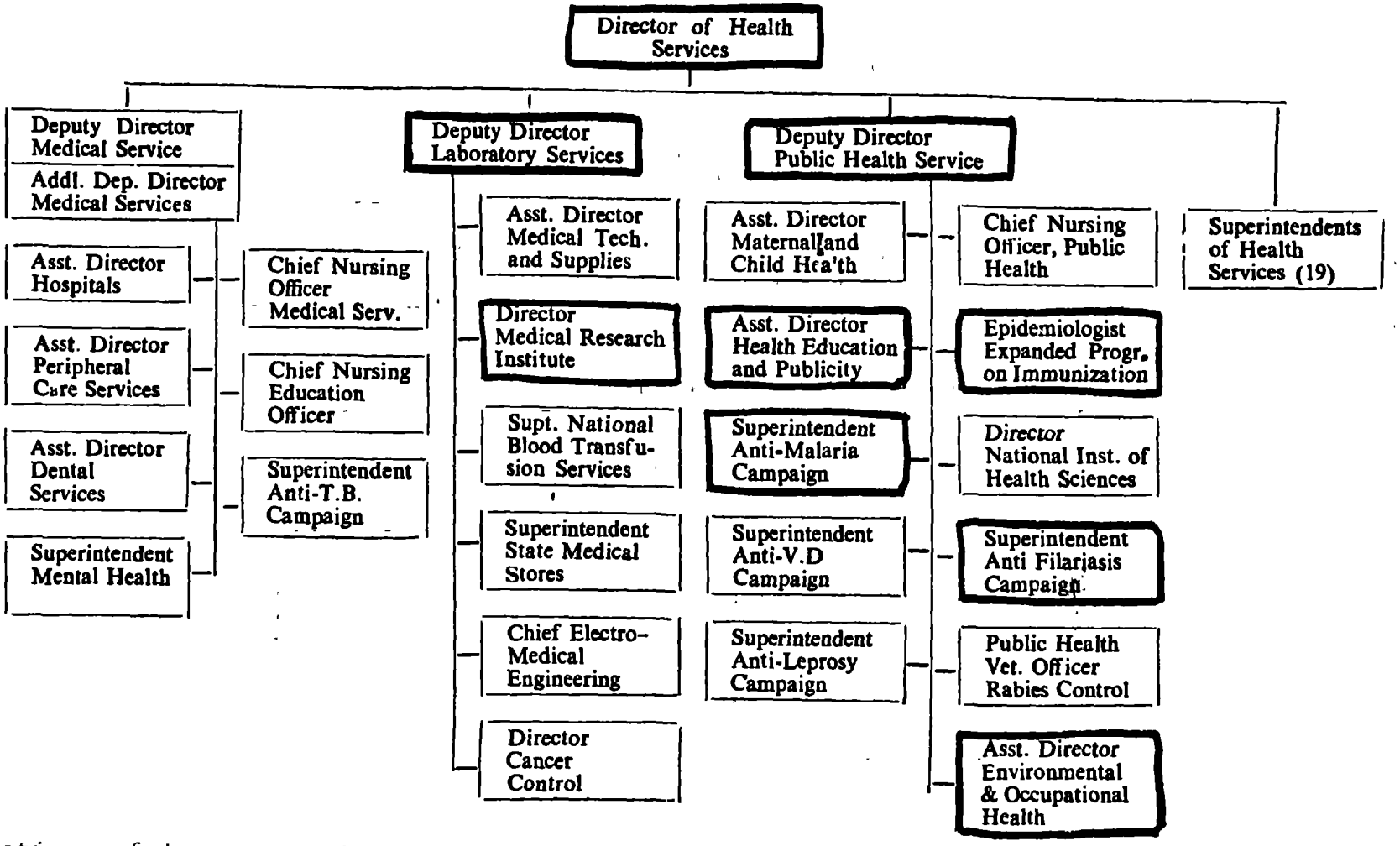
MINISTRY OF HEALTH, SRI LANKA
ORGANIZATION CHART



The sections of importance in preventive health care and environmental hygiene are darkened.

(Source: Annual Health Bulletin 1980. Ministry of Health - Sri Lanka)

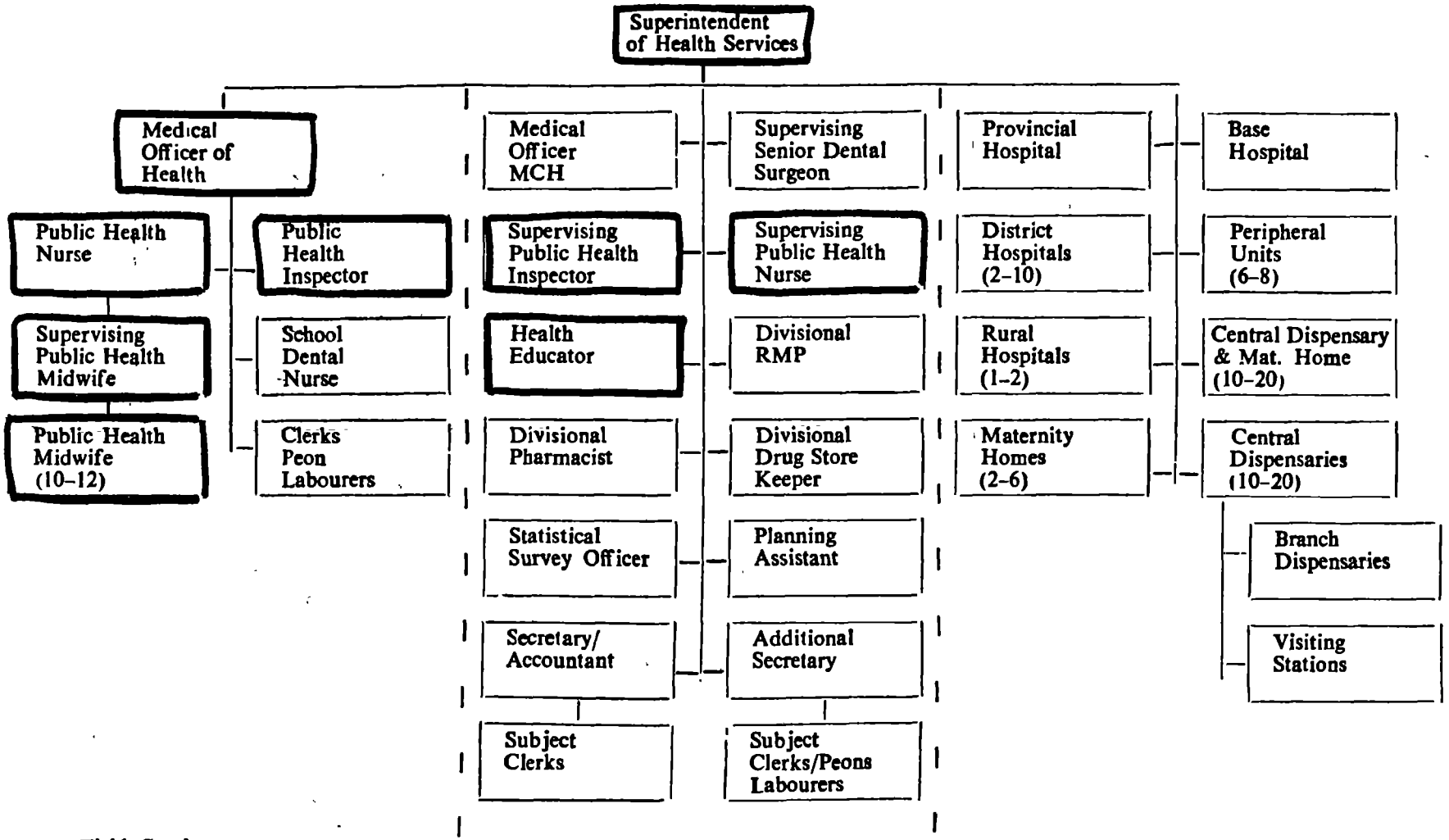
MINISTRY OF HEALTH SRI LANKA
ORGANISATION OF TECHNICAL SERVICES OF THE DEPARTMENT OF HEALTH



The sections of importance in preventive health care and environmental hygiene are darkened.

(Source: Annual Health Bulletin 1980, Ministry of Health - Sri Lanka)

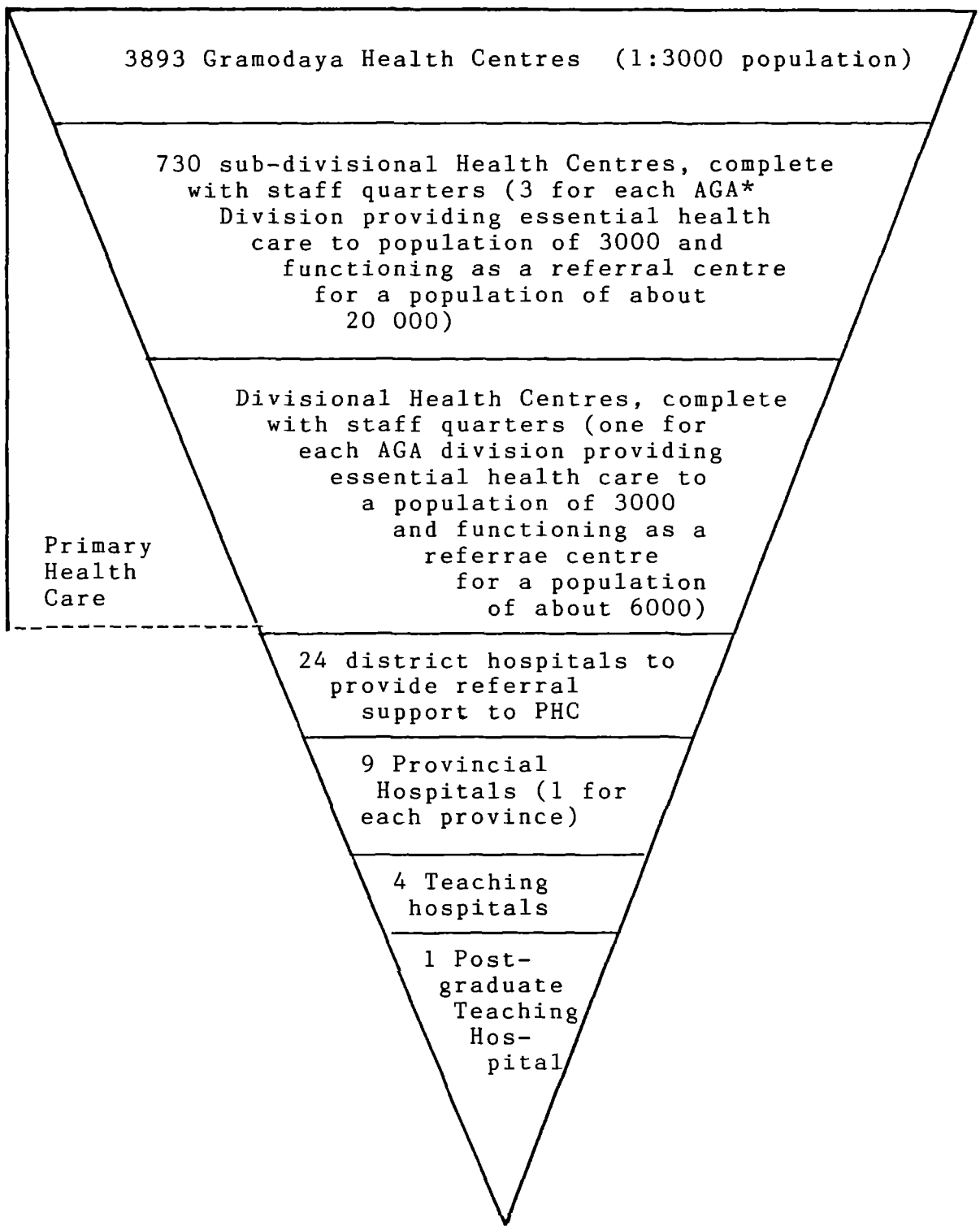
MINISTRY OF HEALTH, SRI LANKA
ORGANISATION OF DIVISIONAL HEALTH SERVICES



The sections of importance in preventive health care and environmental hygiene are darkened.

(Source: Annual Health Bulletin 1980. Ministry of Health - Sri Lanka)

Annex 13. The proposed 'three-tier' PHC (Primary Health Care) system, including the referral network, which is expected to be complete in the country 1991 (Ministry of Health 1981)



* Assistant Government Agent

ERRATA in Annex 14 (p.151)

Should be:

THE RECOMMENDED STANDARDS FOR DRINKING WATER QUALITY - INTERNATIONAL STANDARDS (WHO 1971)

Physical Quality		Maximum Acceptable	Maximum Allowable
Appearance		colourless	
Odour		odourless	
Colour (Units of Platinum cobalt scale)		5	50
Turbidity (FTU)		5	25
Chemical Quality			
pH		7.0-8.5	6.5-9.2
Hardness, total	mg/l $CaCO_3$	100	500
Nitrate	mg/l NO_3	-	45
Chloride	mg/l Cl	200	600
Sulphate	mg/l SO_4	200	400
Fluoride	mg/l F	0.7-1.0	(Recommended limits in temperature of 21.5-26.2C)
Iron, total	mg/l Fe	0.1	1.0
Manganese	mg/l Mn	0.05	0.5
Calcium	mg/l $CaCO_3$	75	200

Bacteria

For individual or small community supplies, by relatively simple measures, such as the removal of obvious sources of contamination from the catchment area and by attention to the coping, lining, and covering, it should be possible to reduce the coliform count of water from even a shallow well to less than 10 per 100 ml. Presistent failure to achieve this, particulary if E.Coli is repeatedly found, should, as a general rule, lead to condemnation of the supply.

Annex 15. Approximate map of the village