Water Quality Study

A Report
May 2010

Democratic Republic of Timor-Leste
Ministry of Health
Environmental Health Division

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Summary

From November 2009 until April 2010 a water quality study was conducted in four districts of Timor-Leste namely Lautem, Covalima, Alieu and Dili. The objective was to gather information necessary for finalization of the Water Quality Monitoring guidelines including development of Water Quality Standards.

The study was very useful in understanding the water quality situation in the country and in selecting the parameters that need regular monitoring. Water quality was assessed by conducting chemical tests covering selected parameters and bacteriological tests at different points of community water supply systems.

Nitrate concentration was found to be higher than the standard value in some sources. Flouride was found in some sources but it was less than the standard value. It is therefore recommended to include these two chemical parameters in future water quality monitoring guidelines for the country.

About 70% of the sources tested were microbiologically contaminated which is a cause for concern as many diseases such as diarrhoea, cholera, typhoid etc. are caused by contaminated water. The results clearly indicate the importance of including bacteriological testing of the water in the national water quality monitoring system.

A large proportion of the stored water in houses was found to be contaminated and therefore promotion of household water treatment and safe storage combined with hygienic practices would be very useful in preventing water-borne diseases.

1. Introduction

Numerous epidemiological studies and outbreak investigations globally have found a direct association between poor water quality and infectious diarrhoea. This causal relationship has been documented from outbreaks in industrialized countries as well as from studies in developing countries where it is not only water contaminated at the source or during distribution that is an issue, but also water stored within the home which may become contaminated. The quantitative relationship can be illustrated by increases in infectious diarrhoea morbidity as contamination levels increase, and also as consumption of water from a single contaminated source increases. WHO estimates that 94% of diarrhoeal cases are preventable through modifications to the environment, including interventions to increase the availability of clean water, and to improve sanitation and hygiene.[1] In addition, a 2005 systematic review concluded that diarrhoeal episodes are reduced by 25% through improving water supply, 32% by improving sanitation, 45% through hand washing, and by 39% via household water treatment and safe storage[2]. Thus, drinking-water quality control and surveillance becomes a key determining factor.

About 62% of the Timorese population has access to improved water supply and 41% to an improved sanitary facility.[3] The rural areas are served by community owned and operated gravity-fed piped systems and privately owned shallow wells. Those not covered by piped water systems are dependent on spring or stream sources which are located near their houses. The urban areas are either supplied with piped public water systems and some households in Dili and other towns depend on private shallow wells.

The quality of public water supply systems is problematic with many of them poorly planned, designed, and operated. Typical deficiencies include low service coverage, poor maintenance, high levels of unaccounted for water, intermittent supply, inappropriate treatment

[1] Pruss A, Corvalan C. Preventing disease through healthy environments: towards an estimate of the environmental burden on disease. World Health Organisation, Geneva 2006.

[2] Combating waterborne disease at the household level. WHO, 2007

[3] WHO/UNICEF joint monitoring programme for water supply and sanitation report, 2008

systems, and poor water quality particularly from surface water sources during the wet season, and frequent failure due to flood and landslide damage to transmission pipelines.

There is no systematic monitoring of water quality. In the recent past, laboratory facilities for water quality analysis have been installed under National Directorate for Water and Sanitation, Ministry of Infrastructure. The most common diseases in Timor-Leste are acute respiratory infection and diarrhoea disease, followed by malaria and dengue infections. It is evident that at any point of time substantial numbers of people are ill, due to causes related to poor hygiene, inadequate sanitation and/or unsafe water supply.[4] It is clearly stated in the National Water Sanitation and Health Strategy of the Ministry of Health that prevalence of these diseases demands strengthening the performance of water and sanitation (watsan) sector by establishing health linkages. To that effect the Environmental Health Department under the Ministry of Health has taken the initiative to develop a Water Quality Monitoring guideline including development of water quality standards with support from WHO.

WHO's drinking water quality guidelines provide a list of bacteriogical and chemical parameters with guideline values that are of concern to public health. However, it is not possible for any country to monitor all the parameters due to the extensive requirement of human and financial resources. It is the responsibility of countries to select parameters that are of concern. In order to identify the water quality parameters that are of concern to Timor-Leste, a water quality sample study was initiated in 2009-10.

The objective of the study was to gather information necessary for finalizing the water quality monitoring guidelines including development of water quality standards for Timor-Leste.

The specific objectives were to gather information regarding:

- Chemical water quality of samples from spring sources, stream sources and handpumps or wells which are used for drinking.

[4] National Water-Sanitation-Health Strategy, 2006 – 2013

- Bacteriological quality of samples taken both at the source, public tapstands, and household storage containers which are used for drinking.

The pilot study was conducted from November 2009 until April 2010 in four districts namely Lautem, Alieu and Covalima and Dili town covering a total of 92 sources .

The study was conducted by the Environmental Health Division with support from the WHO country office and the WHO Regional Office for South-East Asia.

2. Methodology

The study was conducted by a team from the Environmental Health Division and Department of Water Supply and Sanitation through field visits to various water sources with the use of Del Aqua Kit, PH meter, Conductivity meter, Turbidity meter and spectrophotometer. Water sources were tested for 11 physical, bacteriological and chemical parameters.

2.1 Selection of water sources

The study was carried out in four districts representing the eastern, central and western regions. Lautem, Alieu, Covalima and Dili districts were selected, details on the schemes included in the study. Geographic differences were considered and therefore districts in coastal as well as hilly regions were included. Various water sources such as springs, wells, handpumps, water stored in reservoirs and in household storage system were tested with a distribution between the districts as given in Table 2.1.

Table 2.1: *Distribution of water sources for water quality study*

District	Villages	No of water sources tested
Lautem	14	2 reservoirs
		2 handpumps
		6 wells
		3 public tapstands

District	Villages	No of water sources tested
		11 household stored water
		4 spring sources
Covalima	16	2 Handpumps
		8 wells
		3 public tapstands
		1 tapstand
		8 household stored water
		5 spring sources
Alieu	9	3 reservoirs
		2 wells
		3 tapstands
		3 household stored water
		2 spring sources
Dili	1 urban area	4 reservoirs
		2 handpumps
		14 wells
		2 public tapstands
		1 household stored water

A total of nine reservoirs, 11 spring sources, six handpumps, 30 wells, nine public tapstands and 23 household stored water sources were tested for both chemical and microbiological parameters.

The parameters were chosen according to the following considerations:

- Health relevance
- Basic information on the general water chemistry

The following parameters were tested:

- Thermotolerant coliform bacterial and E coli
- pH
- Temperature
- Conductivity (EC)
- Turbidity
- Sulfate
- Fluoride
- Nitrate
- Total iron
- Arsenic

Since there are not many industries in Timor-Leste, chemicals which are of natural origin (arsenic and fluoride) and which are associated with the use of fertilizers and sewage (nitrate) were selected for the study.

2.2 Sampling methods

At each system, samples were taken:

- A private or public tapstand sample taken at the tapstand of the lowest part of the distribution system.
- A household sample, taken from the drinking water storage container of a randomly selected household and a reservoir.
- A source sample, taken as close to the actual source itself mainly spring, well and handpump.

All samples were analysed for microbiology (faecal coliforms) while the chemical and physical tests were carried out only on one sample from the same source. Chemical and physical properties are not expected to change during transmission from source to tap; while microbiological contamination could occur at points of leakage at any stage in between the source and tap, as well as through careless storage/handling in the house.

All the parameter tests were carried out in the field, using the following equipment:

- Wagtech and Del Aqua Water testing kits

3. Results

The complete results of the physical/chemical analyses and the bacteriological analyses are given in Annex 2. In the following sections the results are analysed. It should, however, be remembered that the number of sources included in the survey is fairly small and too detailed an interpretation of the data might lead to misconceptions. The study was conducted during the rainy season which may be one of the reasons for very high bacteriological contamination.

3.1 Chemical Parameters

In Table 3.1 the findings from the chemical analysis are summarized and compared with the recommended guideline values for Timor-Leste.

Table 3.1: *Chemical parameters*

All sources				
Parameter	Lowest value, 59 samples	Highest value, 59 samples	Average, 59 samples	Timor-Leste Recommended
PH	6.20	8.90	-	6.5 - 8.5
TDS (mg/L)	9	60300	8157.2	600 (WHO)
Temperature Celsius	19.6	32.7	27.1	-
Turbidity (NTU)	0.2	68.2	10.5	5
Iron (mg/L)	0	288	7.1	0.3
Sulphate (mg/L)	0	650	54.6	250
Fluoride (mg/L)	0	0.1	0.18	1.5
Nitrate (mg NO3/L)	0	50	7.9	10
Arsenic (mg/L)	0	0	0	0.01

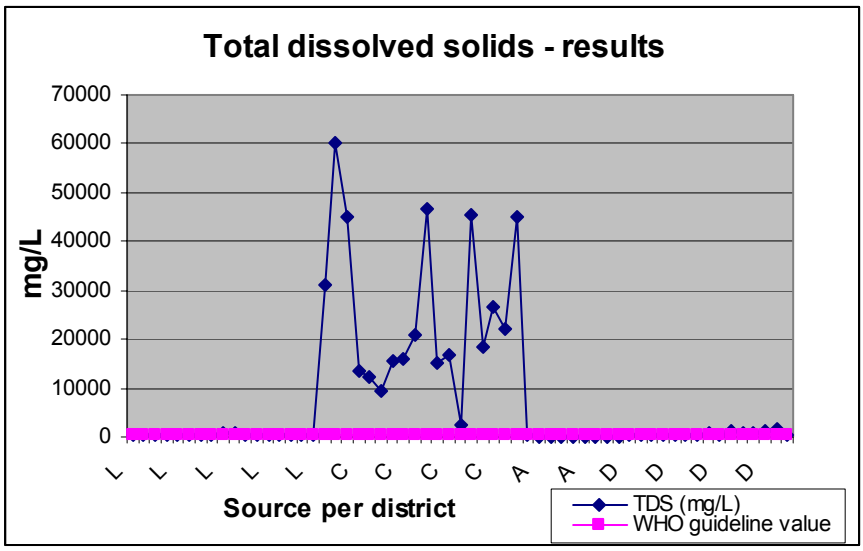
Spring sources				
Parameter	Lowest value, 22 samples	Highest value, 22 samples	Average, 22 samples	Timor-Leste Recommended
PH	6.5	8.7	-	6.5 - 8.5
TDS (mg/L)	9	45200	7562.9	600 (WHO)
Temperature Celsius	20.1	32.7	26.9	-
Turbidity (NTU)	0.5	59.0	5.9	5
Iron (mg/L)	0	0.4	0.08	0.3
Sulphate (mg/L)	0	200	36.8	250
Fluoride (mg/L)	0	0.3	0.09	1.5
Nitrate (mg NO3/L)	0	0.7	0.16	10
Arsenic (mg/L)	0	0	0	0.01
Ground water				
Parameter	Lowest value, 37 samples	Highest value, 37 samples	Average, 37 samples	Timor-Leste Recommended
PH	6.2	8.9	-	6.5 - 8.5
TDS (mg/L	40.3	60300	8510.7	600 (WHO)
Temperature Celsius	19.6	30.9	27.2	-
Turbidity (NTU)	0.2	87.9	13.2	5
Iron (mg/L)	0	288	11.3	0.3
Sulphate (mg/L)	0	650	65.1	250
Fluoride (mg/L)	0	0.98	0.2	1.5
Nitrate (mg NO3/L)	0	50	12.5	10
Arsenic (mg/L)	0	0	0	0.01

As per the chemical test results, some of the water sources are turbid, have very high total dissolved solids, iron and nitrate. Some samples showed presence of fluoride but well within the permissible limit. Arsenic was not detected in any source.

pH

Only five sources have a slight of deviation from the standard pH range for the country. Although pH usually has no direct impact on consumers, it is one of the most important operational water quality parameters. In places where water treatment plants are operational, careful attention to pH control is necessary at all stages of water treatment to ensure satisfactory water clarification and disinfection. For effective disinfection with chlorine, the pH should preferably be less than 8; however, lower-pH water is likely to be corrosive. Corrosive water will cause leakages in metallic and iron pipes. The pH of the water entering the distribution system must be controlled to minimize the corrosion of water mains and pipes in household water systems.

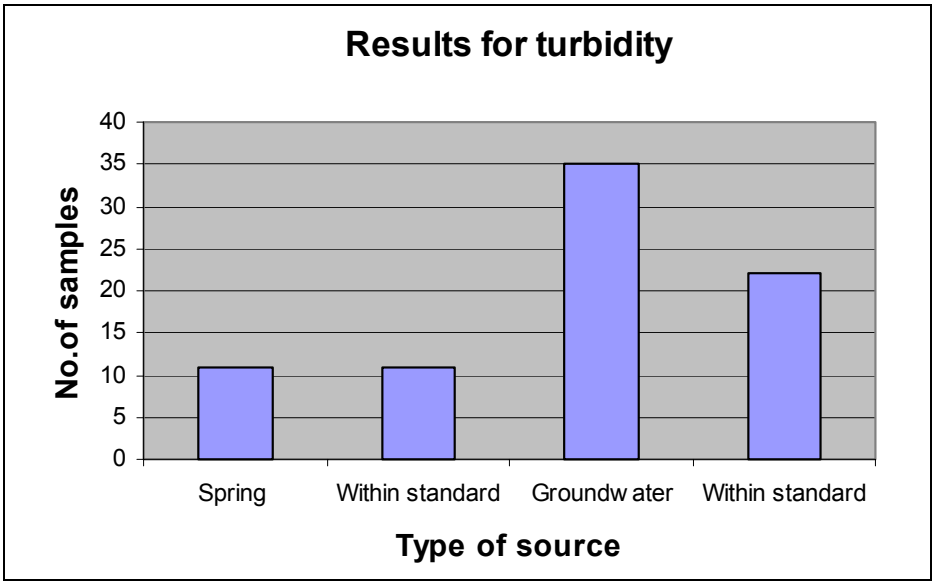
Total dissolved solids (TDS)



The dissolved minerals in water are commonly referred to as total dissolved solids. The minerals are basically compounds of calcium, magnesium and sodium. Some types of dissolved solids are specifically dangerous even in low quantities and include arsenic and flouride. All the samples from Covalima district were found with very high TDS ranging from 2660 mg/L - 60500 mg/L. These sources were tested for both arsenic and

fluoride. None of the sources in Covalima had arsenic, whereas traces of fluoride were found which are well within the national standard. Therefore, the high TDS may be due to saline water as the sources are in the coastal area. The palatability of water with a TDS level of less than 600 mg/litre is generally considered to be good; drinking-water becomes significantly and increasingly unpalatable at TDS levels greater than about 1000 mg/litre. The presence of high levels of TDS may also be objectionable to consumers, owing to excessive scaling in water pipes, heaters, boilers and household appliances.

Turbidity



Turbidity levels are higher in wells (ground water) than spring sources which may be due to lack of protection of wells from surface water especially during monsoon. Turbidity in drinking-water is caused by particulate matter that may be present from source water. The appearance of water with a turbidity of less than 5 NTU is usually acceptable to consumers, although this may vary with local circumstances. Particulates can protect micro-organisms from the effects of disinfection and can stimulate bacterial growth. In all cases where water is disinfected, the turbidity must be low so that disinfection can be effective.

Iron

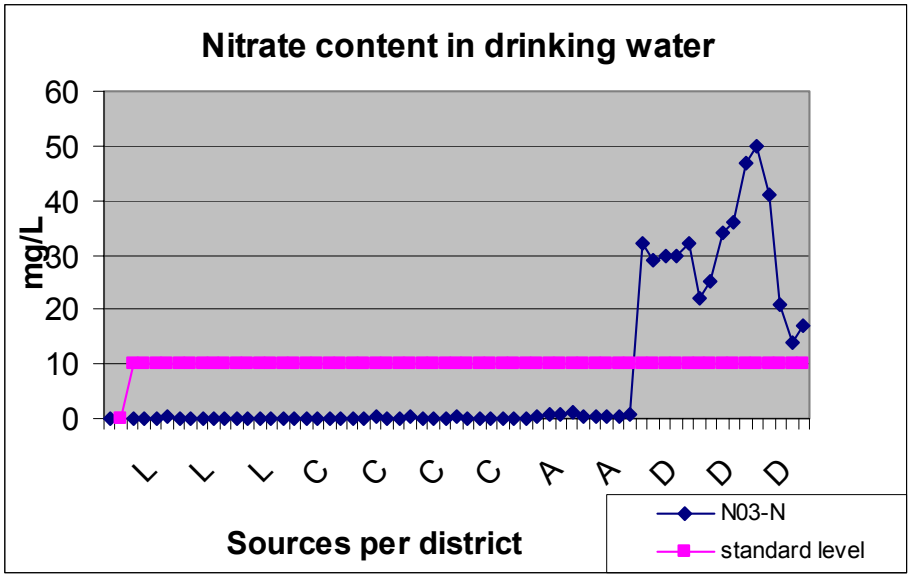
Five sources had iron content higher than the standard level, whereas two sources had extremely high levels. There is a need to reconfirm these two sources. Significant concentrations of iron and manganese occur throughout the world. Although these chemicals are not suspected of causing direct health effects, through their presence in drinking-water, they can cause severe discoloration of water, which may lead to consumers turning to other, microbially unsafe sources. Iron and manganese also frequently cause operational problems in the water supply network.

Sulphate

Only four sources were found to have sulphate over the standard level. The presence of sulfate in drinking-water can cause noticeable taste, and very high levels might cause a laxative effect in unaccustomed consumers. It is generally considered that taste impairment is minimal at levels below 250 mg/litre.

Nitrate

In Dili district 15 ground water samples had nitrate concentration above the national standard. Nitrate may occur naturally although its presence in drinking-water is more often associated with contamination by excessive use of fertilizers in combination with inappropriate farming practices and improper disposal of sewage. This chemical occurs widely throughout the world in both groundwater and surface water, and presents a particular problem in shallow wells. Nitrate is a major problem for bottle-fed infants, in whom the risk of methaemoglobinaemia ("blue-baby syndrome"), increases as the concentration of nitrate rises above 50 mg/L. The risk is increased by the presence of nitrite, which is a much more potent methaemoglobinaemic agent than nitrate, and by the presence of microbial contamination, which can lead to gastric infections in infants.



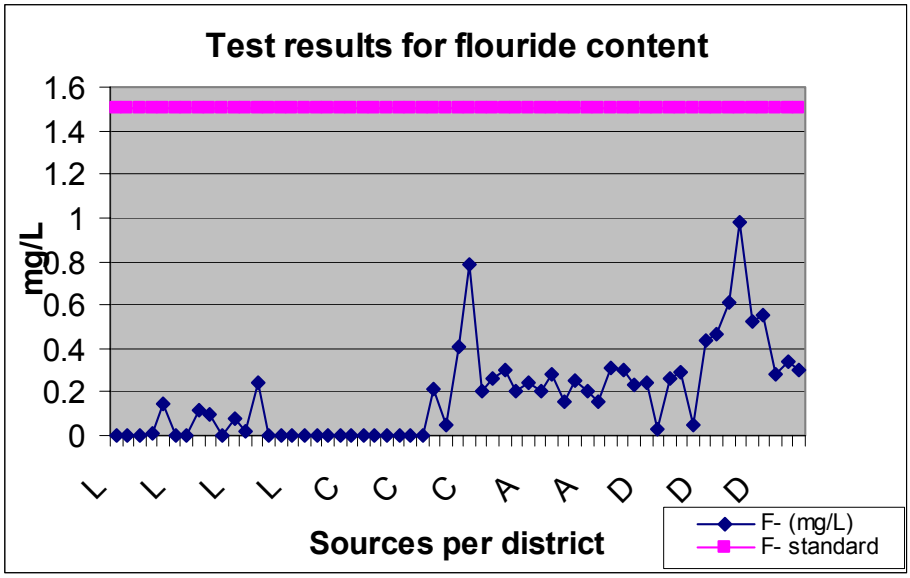
L-Lautem, C-Covalima, A –Alieu, D - Dili

Temperature

The temperatures of the samples vary from 19.6 to 32.7 Celsius. Cool water is generally more palatable than warm water, and temperature will impact on the acceptability of a number of other inorganic constituents and chemical contaminants that may affect taste. High water temperature enhances the growth of micro-organisms and may increase taste, odour, colour and corrosion problems.

Flouride

More than 50% of the sources had some concentrations of flouride, however within the standard level of 1.5 mg/L. The following graph indicates that the fluoride contents are more prevalent in Alieu and Dili districts.



L- Lautem district, C – Covalima, A – Alieu, D - Dili

Arsenic

None of the ground water sources had Arsenic.

3.2 Bacteriological results

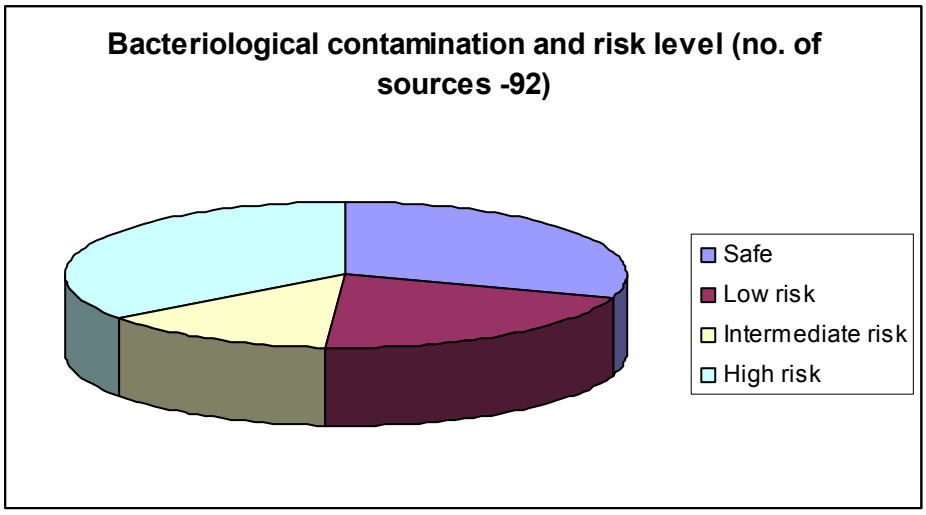
The indicator used for the bacteriological quality of the water has been faecal coliform bacteria, (thermotolerant coliform bacteria). The national standard proposes that for all water intended for drinking, faecal coliform must not be detected in a 100 ml sample.

The WHO drinking water quality guidelines classify microbiological results with regard to health risk as shown in Table 3.2.

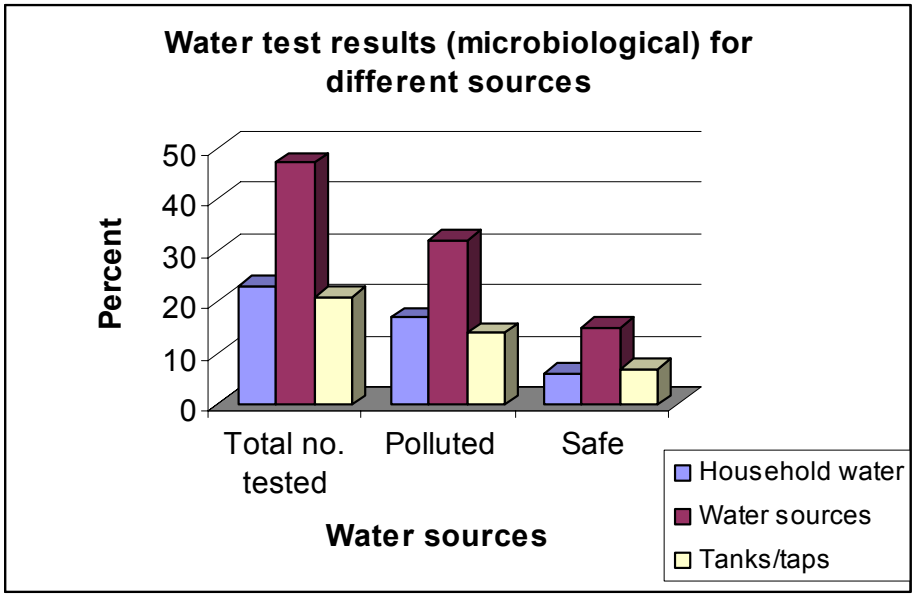
Table 3.2: *WHO classification of bacteriological water quality*

Thermotolerant Coliform per 100 ml, CFU/100ml	Risk classification
0	In accordance with WHO guidelines
1 – 10	Low risk
10 – 100	Intermediate risk
>100	High risk

The results of the bacteriological tests are summarized in annex 2. Samples too numerous to count have been entered in the database as having a value of 1000 CFU/100ml.



A total of 92 sources including spring sources, reservoirs, handpumps, wells, public tapstands and stored household water were tested for bacteriological contamination. The results showed that only 30% of the sources are safe without any faecal contamination while the rest of the sources were contaminated. While 21% of the sources fall in low risk, 14% are in intermediate risk and 35% in the high risk category.



4. Recommendations

The results from this study are useful in formulating and finalizing the water quality monitoring guideline and updating standards for Timor-Leste. The following is recommended for incorporation:

(a) Nitrate content is found to be very high in Dili and therefore it may need monitoring on a regular basis. There is also a need to carry out sanitary inspection of these sources to find out the source of nitrate and to take immediate remedial action.

(b) Flouride is found in many sources, however it is within the national standard. Since it has a significant health risk, it would be worth testing in other districts and if found prevalent, it may need regular monitoring.

(c) It is recommended to test some of the ground water sources in Dili which are in close proximity to mechanical workshops for petroleum products.

(d) The study clearly shows that most of the water sources including spring sources, handpumps, wells, reservoirs and household stored water are bacteriologically contaminated and therefore

there is a need to monitor the microbiological quality of water at these points on a regular basis.

(e) TDS levels in Covalima district are extremely high. Since it is in a coastal area, the high TDS may be due to saline water. However, it is recommended that the test results be reconfirmed and, at the same time, sanitary inspection be carried out to rule out other sources such as agricultural activities and sewage disposal.

(f) If the test results are reconfirmed and if the contamination is due to salt water, a health check-up of the people who consume water from these water sources should be conducted regularly. At the same time, it would be advisable to provide alternative water sources for human consumption. These existing sources may be used for washing and bathing. An alternative solution would be to harvest rainwater which can be done at the household level or at the community level.

(g) A dynamic monitoring system should be set up for microbiological contamination whereby the office which conducts these tests can immediately inform the consumers to take remedial action to drink safe water if the test results show grossly contaminated water. The long-term action would be to prevent contamination by taking corrective action.

(h) There is a need to promote household water treatment through boiling, filtration, solar disinfection of water, adding chlorine (depending on the type of water) and safe storage at the household level.

(i) Introducing water safety plans which include sanitary inspection would be very useful as it would help to assess the whole water supply system, identify the sources of pollution, and identify the critical points for contamination which in turn, would provide direction to prevent contamination. Therefore, a combination of a water safety plan and verification by testing with a water test kit would be a very appropriate tool to prevent water contamination.

Annex 1

Chemical Test Results

Date	Sampling point	source type	pH	TDS	Temp.	Turb.	Fe	Sulphate	F-	N03-N	As
			6.5-8.5	(mg/L)	(oC)	(NTU)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)
				600 (WHO)	NS	5	0.3	250	1.5	10	0.01
07/11/09	Suco Maina 1	SP	7.9	254	28.2	2	0.03	4	ND	ND	ND
07/11/09	Aldeia Punu	PT	8.4	421	31.2	1.9	0.03	20	ND	ND	ND
07/11/09	Aldeia Punu	Res	8.2	426	28.7	1.6	0.04	21	ND	ND	ND
07/11/09	Suco Bauro	Well	7.3	545	27.4	10.7	0.08	2	0.01	0.3	ND
07/11/09	Suco Fuiloro	Well	7.4	547	28	0.7	0.03	3	0.15	ND	ND
07/11/09	Suco Fuiloro	HH	8.9	488	27.1	1.2	0.05	2	ND	ND	ND
08/11/09	Aldeia Caiwaca	PT	7.2	560	32.7	0.5	0.02	1	ND	ND	ND
08/11/09	Aldeia Caiwaca	Res	7.4	549	27.4	5.8	0.01	2	0.12	ND	ND
08/11/09	Suco Souro/Foema,a	Well	7.4	681	26.3	65.7	0.12	7	0.10	ND	ND
08/11/09	Aldeia Carano	HP	7.5	655	27.4	5.5	0.11	2	ND	ND	ND
08/11/09	Suco Culuhun (A)	Well	8.3	469	27.5	5.3	0.53	4	0.08	ND	ND
08/11/09	Suco Culuhun (B)	Well	8.4	398	25.6	2.7	0.02	2	0.02	ND	ND
08/11/09	Fuiloro	Well	8.4	384	26.1	4.0	0.03	4	0.24	ND	ND
09/11/09	Aldeia Asalaino	HP	8.8	483	27.1	4.9	**288**	18	ND	ND	ND
09/11/09	Aldeia Iralafai	SP	8.4	487	28.1	0.5	ND	ND	ND	ND	ND
09/11/09	Papa Intake	SP	7.6	516	28.8	1.6	0.05	ND	ND	ND	ND
09/11/09	Puahopo Spring	SP	8.7	523	26.9	0.5	ND	ND	ND	ND	ND
19/11/2009	Aldeia Zoak	SP	7.3	31100	28.3	2.0	0.38	200	ND	ND	ND
19/11/2009	Aldeia Zoak	Well	8	60300	28.7	**11.2**	0.02	**650**	ND	ND	ND
19/11/2009	Aldeia Teda	Well	7.6	45000	29.8	**68.2**	0.04	**300**	ND	ND	ND
20/11/2009	Aldeia Lebo	PT	8.2	13530	25.2	**6.9**	0.09	20	ND	ND	ND
20/11/2009	Halilaran	PT	8.5	12230	24	**10.3**	0.05	24	ND	0.2	ND
20/11/2009	Halilaran	SP	**8.6**	9350	20.1	3.7	0.02	16	ND	ND	ND
20/11/2009	We Bua Laran	SP	7.9	15410	23.4	3.8	0.01	7	ND	ND	ND
20/11/2009	Tilomar Tulaeduk	Well	8.0	15870	25.3	**87.9**	0.08	22	ND	0.3	ND
20/11/2009	Suco Lalawa	Well	7.8	20700	24.7	**7.8**	0.02	25	ND	0.1	ND
20/11/2009	Aldeia Lontane	HP	6.5	46500	32.8	4.7	0.04	33	ND	ND	ND
20/11/2009	Aldeia Tabolok	HP	7.9	15200	29	2.1	**112**	**475**	0.21	0.1	ND

Date	Sampling point	source type	pH	TDS	Temp.	Turb.	Fe	Sulphate	F-	N03-N	As
			6.5-8.5	(mg/L)	(oC)	(NTU)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)
				600 (WHO)	NS	5	0.3	250	1.5	10	0.01
20/11/2009	Wetaba	SP	8.3	16600	27.6	1.5	ND	200	0.05	0.4	ND
20/11/2009	Sukabilaran	Well	8	2660	28.9	**37.1**	ND	7	0.41	ND	ND
20/11/2009	Aldeia Raifila	Well	7.3	45600	25.0	**44.4**	0.04	175	0.79	0.1	ND
21/11/2009	Zumalai Vila	PT	6.9	18470	25.0	1.3	0.22	27	0.20	ND	ND
21/11/2009	Aldeia Camenasa	Well	6.8	26500	30.9	1.1	ND	**425**	0.26	ND	ND
21/11/2009	SAS Sukabilaran	Well	6.9	22300	31.1	1.2	ND	200	0.30	ND	ND
21/11/2009	Mata Air	SP	6.7	45200	30.1	1	0.01	200	0.20	0.1	ND
27/11/2009	MANTANE	Well	7.0	248	26.3	4.5	0.07	18	0.24	0.5	ND
27/11/2009	HULAREMA	Res	7.3	128	23.9	59	0.17	28	0.2	0.7	ND
27/11/2011	MALERE A	Res	7.7	181	23.5	10	0.13	26	0.28	0.6	ND
27/11/2012	BESKEM	Well	6.7	81.4	23.0	66	0.63	16	0.16	1.2	ND
27/11/2013	BESKEM	PT	6.2	40.3	19.6	3.7	0.04	17	0.25	0.5	ND
28/11/2009	TURSALEFA. A	SP	7.6	165	23.7	3.9	0.21	1	0.20	0.5	ND
28/11/2010	TURSALEFA. B	SP	7.6	130	21.8	3.2	0.14	3	0.16	0.5	ND
28/11/2011	TURSALEFA	Res	7.3	144	29.9	3.4	0.06	5	0.31	0.5	ND
28/11/2014	REMEXIO VILA	PT	6.5	9	32.9	5.7	0.21	5	0.30	0.9	ND
12/12/09	Culu Hun B	Well	7.4	456	20.3	0.4	2	**0.4**	0.23	32	ND
12/12/09	Culu Hun A	Well	7.2	397	28.7	0.2	1	ND	0.24	29	ND
12/12/09	Comoro B	Well	7.1	334	28.0	**0.7**	0.2	0.01	0.03	30	ND
12/12/09	Comoro D	Well	7.9	340	28.5	0.3	0.2	0.01	0.26	30	ND
12/12/09	Comoro E	Well	7.9	365	28.5	0.3	ND	ND	0.29	32	ND
18/02/2010	Bidau.M	Well	7.1	375	28.5	**0.9**	0.8	ND	0.05	22	ND
18/02/2010	Lab. Nas	Well	7.2	357	28.4	0.5	0.1	ND	0.44	25	ND
18/02/2010	MDS	Well	7.1	615	30.8	**17.4**	1.6	ND	0.47	34	ND
22/02/2010	Caicoli	HP	7.3	485	22.0	0.4	1.7	0.2	0.61	36	ND
22/02/2010	Cacaulidun	Well	7.7	1124	29.3	0.4	4.0	0.02	0.98	47	ND
22/02/2010	Bairo Pite	HP	7.4	804	29.5	0.3	1.7	0.01	0.52	50	ND
22/02/2010	KP. Alor	Well	7.8	647	29.3	**19.0**	0.1	**0.9**	0.6	41	ND
22/02/2010	Hera. A	Well	7.1	1026	24.3	2.9	0.3	0.1	0.28	21	ND
22/02/2010	KP. Baru	Well	**8.8**	1654	28.5	0.8	0.2	0.1	0.3	14	ND
22/02/2010	Matadoru	Well	8.4	269.0	25.8	4.4	0.5	0.2	0.3	17	ND
		Lowest	6.2	9	19.6	0.2	0.0	0.0	0.0	0	0.0
		Highest	8.9	60300	32.7	68.2	288.0	650.0	1.0	50	0.0
		Average		8157.2	27.1	10.5	7.1	54.6	0.18	7.9	0

Annex 2

Bacteriological test results

No	Date	Sampling point	Type of source	Total Coliform (CFU/100ml) 0 (recommended)
1	07/11/09	Suco Maina 1	HH	62
2	07/11/09	Suco Maina 1	SP	0
3	07/11/09	Aldeia Punu	PT	36
4	07/11/09	Aldeia Punu	HH	55
5	07/11/09	Aldeia Punu	Res	36
6	07/11/09	Suco Bauro	Well	1
7	07/11/09	Suco Bauro	HH	0
8	07/11/09	Suco Fuiloro	HH	1
9	07/11/09	Suco Fuiloro	PT	0
10	07/11/09	Suco Fuiloro	Well	1
11	07/11/09	Suco Fuiloro	HH	0
12	08/11/09	Aldeia Caiwaca	PT	0
13	08/11/09	Aldeia Caiwaca	HH	0
14	08/11/09	Aldeia Caiwaca	Res	2
15	08/11/09	Suco Souro/Foema,a	Well	24
16	08/11/09	Suco Souro/Foema,a	HH	42
17	08/11/09	Aldeia Carano	HP	4
18	08/11/09	Aldeia Carano	HH	6
19	08/11/09	Suco Culuhun (A)	Well	0
20	08/11/09	Suco Culuhun (A)	HH	1
21	08/11/09	Suco Culuhun (B)	Well	15
22	08/11/09	Suco Culuhun (B)	HH	6
23	08/11/09	Fuiloro	Well	2

No	Date	Sampling point	Type of source	Total Coliform (CFU/100ml) 0 (recommended)
24	09/11/09	Aldeia Asalaino	HP	0
25	09/11/09	Aldeia Asalaino	HH	0
26	09/11/09	Aldeia Iralafai	SP	0
27	09/11/09	Papa Intake	SP	0
28	09/11/09	Puahopo Spring	SP	0
29	19/11/2009	Aldeia Zoak	SP	4
30	19/11/2009	Aldeia Zoak	PT	75
31	19/11/2009	Aldeia Zoak	Well	TNC
32	19/11/2009	Aldeia Teda	HH	TNC
33	19/11/2009	Aldeia Teda	Well	TNC
34	19/11/2009	Aldeia Teda	HH	TNC
35	20/11/2009	Aldeia Lebo	PT	0
36	20/11/2009	Aldeia Lebo	HH	0
37	20/11/2009	Halilaran	PT	TNC
38	20/11/2009	Halilaran	SP	1
39	20/11/2009	We Bua Laran	SP	TNC
40	20/11/2009	We Bua Laran	HH	TNC
41	20/11/2009	Tilomar Tulaeduk	Well	TNC
42	20/11/2009	Tilomar Tulaeduk	HH	TNC
43	20/11/2009	Suco Lalawa	Well	1
44	20/11/2009	Aldeia Lontane	HP	24
45	20/11/2009	Aldeia Tabolok	HP	0
46	20/11/2009	Aldeia Tabolok	HH	1
47	20/11/2009	Wetaba	SP	TNC
48	20/11/2009	Sukabilaran	Well	TNC
49	20/11/2009	Sukabilaran	HH	TNC
50	20/11/2009	Aldeia Raifila	Well	TNC
51	21/11/2009	Aldeia Raifila	HH	TNC

No	Date	Sampling point	Type of source	Total Coliform (CFU/100ml) 0 (recommended)
52	21/11/2009	Zumalai Vila	PT	1
53	21/11/2009	Aldeia Camenasa	Well	TNC
54	21/11/2009	SAS Sukabilaran	Well	0
55	21/11/2009	Mata Air	SP	6
56	27/11/2009	MANTANE	Well	TNC
57	27/11/2009	HULAREMA	Res	TNC
58	27/11/2010	HULAREMA	HH	TNC
59	27/11/2011	MALERE A	Res	TNC
60	27/11/2012	BESKEM	Well	TNC
61	27/11/2013	BESKEM	PT	12
62	28/11/2009	TURSALEFA. A	SP	TNC
63	28/11/2010	TURSALEFA. B	SP	TNC
64	28/11/2011	TURSALEFA	Res	21
65	28/11/2012	REMEXIO VILA	PT	TNC
66	28/11/2013	REMEXIO VILA	HH	TNC
67	28/11/2014	REMEXIO VILA	PT	TNC
68	28/11/2015	KOTA-LAU	HH	0
69	12/12/09	Culu Hun B	Well	0
70	12/12/09	Culu Hun A	Well	0
71	12/12/09	Lahane	Res	0
72	12/12/09	Bemos WTP	Res	0
73	12/12/09	Central WTP	Res	0
74	12/12/09	Comoro B	Well	0
75	12/12/09	Comoro D	Well	0
76	12/12/09	Comoro E	Well	0
77	18/02/2010	Benamauk	Res	4
78	18/02/2010	Bidau.M	Well	TNC
79	18/02/2010	Lab. Nas	Well	14

No	Date	Sampling point	Type of source	Total Coliform (CFU/100ml) 0 (recommended)
80	18/02/2010	MDS	Well	TNC
81	18/02/2010	Becusi	HH	6
82	18/02/2010	Manleuana	PT	0
83	18/02/2010	Manleuana	PT	13
84	22/02/2010	Caicoli	HP	7
85	22/02/2010	Cacaulidun	Well	TNC
86	22/02/2010	Bairo Pite	HP	8
87	22/02/2010	KP. Alor	Well	TNC
88	22/02/2010	Hera. A	Well	0
89	22/02/2010	KP. Baru	Well	TNC
90	22/02/2010	Matadoru	Well	TNC
91	22/02/2010	Lahane	Well	0
92	24/02/2010	Laboratory DN-SAS		TNC

From November 2009 until April 2010 a water quality study was conducted in four districts of Timor-Leste namely Lautem, Covalima, Alieu and Dili. The objective was to gather information necessary for finalization of the Water Quality Monitoring guidelines including development of Water Quality Standards.

The study was very useful in understanding the water quality situation in the country and in selecting the parameters that need regular monitoring. Several physical, chemical and bacteriological parameters were tested under the study.

The results clearly indicate the importance of including bacteriological testing of the water in the national water quality monitoring system.

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