A GEOCHEMICAL CLASSIFICATION OF GROUNDWATER OF SRI LANKA

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Abstract : This paper presents a detailed geochemical classification of groundwater of Sri Lanka. In view of the fact that nearly 85% of the population of Sri Lanka use well water and other non-piped water for their drinking water supply, information on the chemistry of the groundwater is essential. Depending on its chemistry, the groundwater of Sri Lanka has been classified into 4 main types, namely, Ca, Mg, Na/K and non-dominant cation types. Each of these major groups are sub-divided into 2 or 4 sub-groups. It was revealed that the chemistry of the groundwater is markedly dependent on the underlying geology as well as the climate. The dry zone in particular is abundant in the Na/K type of water whereas the wet zone had Ca and non-dominant cation types. It is also shown that the proposed classification has useful applications in delineating areas susceptible to waterborne health hazards.

1. Introduction

The need for clean water as one of the most essential commodities for mankind can never be over-emphasized. Groundwater monitoring is one of the most important aspects of groundwater resource management and prevention of groundwater pollution. Most environmental research activities have been centered on rivers, lakes and the atmosphere of developed nations. Very few case studies have been reported from developing countries even though clean water is often a scarce commodity in such countries.

In Sri Lanka, a country of 15 million people, only 10 – 15% of the people have access to piped water, and the majority of the country's health problems are related to its aquatic environment. Most people use small, unprotected wells, and in rural settlements, reservoirs and stream and river channels are the main sources of drinking water. The proper disposal of human and other wastes through sewerage systems and latrines is also severely limited, less than a third of the population having satisfactory latrine facilities. The poor water supply and excreta disposal systems have resulted in 40% of the Sri Lankan population being affected by typhoid, amoebic and bacillary dysentery, infectious hepatitis, gastro-enteritis, colitis and worm infections. The need to carefully monitor the groundwater quality of Sri Lanka, is therefore of high priority and upto now this aspect has been neglected.

Environmental geochemistry essentially deals with the geographical distribution of elements and forms the basis for a variety of interdisciplinary studies involving human and animal health, quality of groundwater, agriculture and nutrition, soil fertility, pollution and mineral exploration. The study of the abundance and distribution of some trace elements and the resulting biological manifestations involves geochemists, public health workers, soil scientists, ecologists and nutritionists.

The chemical quality of groundwater is related to the geology of the area concerned. For example, areas underlain by acid igneous rocks such as granite or arenaceous sedimentary rocks generally contain lower levels of essential trace elements — particularly the first row transition elements — than areas underlain by ultrabasic and igneous rocks or shale. These however, may sometimes contain sufficient concentrations of potentially toxic elements.¹⁵

It is the aim of this paper to present a detailed chemical classification of the groundwater of Sri Lanka. It is hoped that this chemical classification would help, not only the hydrogeochemist, but also town and country planners and those engaged in the implementation of rural water supply schemes.

2. Materials and Methods

Figure 1 illustrates the general geology and climate of Sri Lanka and Figure 2, the locations of the sampling points for groundwater. All water samples were collected in acid-washed polyethylene bottles and kept cool and dark until tested. All samples were collected during the period July–December 1982. The appendix shows the details of locations. Three samples were taken from each location, for the determination of the following :

Sample 1 : Total dissolved solids, Cl^- , F^- , SO_4^{2-} , HCO_3^-

Sample 2 : NO_3^- , NO_2^- , NH_4^+

Sample 3 : Na, K, Ca, Mg, Fe, Mn, Co, Cr, Cu, V, Zn, SiO_2

2.1 Analytical procedures

The total dissolved solids (TDS), Cl^- , F^- , SO_4^{2-} and HCO_3^- determinations were carried out using 1000 ml of well-mixed unacidified filtered samples (Sample 1). Following the methods of Brown *et. al.*,¹ TDS SO_4^{2-} Cl^- and HCO_3^- measurements were carried out by gravimetry and titrimetry respectively. The fluoride contents of the water were determined by the use of specific ion electrode.¹³

Figure 2. Map showing the locations of sampling points.

Figure 1. Map showing the climate and geology of Sri Lanka.

A 500 ml sample (Sample 2) was used in the determination of NO_3^- , NO_2^- and NH_4^+ . The NO_3^- contents of the water were determined using a specific ion electrode. The NO_2^- and NH_4^+ contents were determined spectrophotometrically following the method of Brown *et al.*¹

A 2000 ml sample (Sample 3) of filtered water, acidified with 3 ml of reagent grade conc. HNO_3 was used for the determination of metal ions, and total SiO_2 . The V and SiO_2 were determined spectrophotometrically following the method of Brown *et al.*¹ The metals Cu, Co, Cr and Zn were determined by atomic absorption spectrophotometry following pre-concentration using ammonium pyrrolidine dithiocarbamate (APDC)/methyl isobutyl ketone (MIBK). N, K, Ca, Mg, Fe and Mn were determined by atomic absorption spectrophotometry without pre-concentration.⁷

Replicate analyses were made for all samples and inter-laboratory comparisons made. A relative standard deviation of $\pm 1 - 5\%$ was observed.

3. Results and Discussion

3.1 Plotting of data and map making

As the eye is well adapted to the recognition of patterns in spatial data, maps have the capacity to present geochemical information with great impact, and the spatial component becomes an integral part of the compilation and interpretational process. Comparison of hydrogeochemical data with topographic geologic or geochemical information is made easier when all are in map form on the same scale.

Regional geochemical maps are best suited for application in agriculture, ecology and human health investigations. Such an approach has been taken by the Applied Geochemistry Research Group (AGRG) of Imperial College, London and the British Geological Survey, and has proved to be of immense value in a large number of disciplines. Generally this type of map provides the broadest view of large portions or the totality of country. The sampling densities of these maps are below 1 km^2 , over an area in excess 10,000 sq km and are usually presented as moving-average smoothed maps. Local irregularities of the sampling results often obscure rather than clarify any attempt to extract diagnostic patterns in the production of contour maps at regional scale. These irregularities need to be harmonized, first with suitable smoothing out procedures. Much of the studies in this direction had been carried out by Davis² and Olea.¹¹

3.2 The chemical basis for the classification of groundwater

The major constituents in aquatic systems include Ca, Mg, Na, K, HCO_3^- , CO_3^{2-} , SO_4^{2-} and Cl^- . The proportions of these eight geochemically significant constituents in natural solution provides the basis for naming the water type. To provide a basis for comparison of water types and to relate them to specific environments, a graphic method of illustrating data and appropriate terminology must be adopted.

The Piper diagram¹² is a multiple trilinear diagram for graphic representation of the major chemical constituents of water, and effectively portrays analytical data. Similar analytical techniques were developed by Hill,⁹ Langelier and Ludwig¹⁰ and Romani.¹⁴ The model used in this study is a modification by Hem.⁸ Piper diagrams are used in various ways in hydrogeochemistry. The simplest application is merely to display data to represent distinctions among individual water samples. A fairly recent and promising modification of the Piper diagram involves the use of component cation and anion diagrams to classify water. The water type is generally named after the dominant cations and dominant anions – defined as constituting more than 50% of the cation or anion. This has been accomplished graphically by joining the mid-points of each side of each triangular field which divides each triangular diagram into 4 smaller triangles. Thus a water type is easily named, based on the positioning of the points in the cation and anion triangles. Unless there are non-dominant cations or anions, the water type is named after the cations (Ca, Mg, Na/K) followed by a hyphen and a similar term selected for anion possibilities (SO_4 , Cl, HCO_3/CO_3). When a water type plots in the Piper diagram in the non-dominant cation or non-dominant anion fields, it indicates that on percentage epm basis, no ion is present in an amount greater than 50%. In such instances, non-dominant cation (NDC) or non-dominant anion (NDA) forms the descriptive name.

3.3 The chemistry of the groundwater of Sri Lanka

The groundwater of Sri Lanka can be classified into the following 4 main water types. The appendix shows all chemical data pertaining to this study.

1. Calcium type
2. Magnesium type
3. Sodium/potassium type
4. Non-dominant cation type

Figure 3 illustrates the distribution of these 4 major water types in Sri Lanka. Each type is further sub-divided into the Cl, SO_4 , HCO_3 and NDA types. Table 1 shows the average for the elements and ionic species.

Figure 3. Map showing the distribution of the major groundwater types in Sri Lanka.

Table 1 : Elemental averages for the different water types of Sri Lanka

Water type	total										total										total Hardness ppm, CaCO ₃
	Na	K	Ca	Mg	HCO ₃	SO ₄	Cl	Fe	Mn	Cr	Co	V	Cu	Zn	NO ₃	NO ₂	NH ₄	F	SiO ₂	TDS	
	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppm	
Ca-type	28	15	78	13	222	41	62	1088	76	11	28	58	40	137	4657	113	229	1006	19	358	245
Mg-type	39	38	104	158	393	649	38	1457	65	13	9	38	45	84	1614	62	97	638	10	761	938
Na/K-type	345	35	82	18	253	36	589	1443	112	11	27	51	66	129	6128	114	175	1121	25	617	305
NDC-type	81	19	76	25	253	45	195	1098	79	10	18	22	52	113	3966	113	221	983	18	603	255

3.3.1 The calcium type

Figure 4 illustrates the Piper trilinear diagrams for the calcium water type. In Sri Lanka, this type of water is distributed mainly in the northern, central and in some parts of southern, eastern and north central regions. The Cl type predominates in the northern parts whereas the HCO_3 type is prevalent in the central regions. The effect of salinity and the presence of carbonate rocks in the areas could possibly be attributed to such a distribution. Table 2 shows the correlation matrix for the elements and ionic species analyzed for the calcium type of water in Sri Lanka. The total dissolved solids (TDS) show significant correlations with K, Ca, HCO_3 and Cl. The transition elements however do not show significant correlations for this type of water.

3.3.2 The magnesium type

When compared to the other types of water, the magnesium type is distributed only in relatively smaller areas, the southern parts of the country around Embilipitiya having higher concentrations. In this type of water, only the Cl and SO_4 sub-types could be found. The correlation matrix and the Piper trilinear diagram for the Mg water type are shown in Table 3 and Figure 5 respectively.

Figure 4. Piper trilinear diagrams for the calcium water type.

Table 2 : Correlation matrix for the calcium type

	Na	K	Ca	Mg	HCO ₃	SO ₄	Cl	Fe	Mn	Cr	Co	V	Cu	Zn	NO ₃	NO ₂	NH ₄	F	SiO ₂	TDS
Na	1.000	0.472*	0.479*	-0.021	0.344	0.028	0.737*	-0.177	0.063	-0.107	0.019	0.072	0.317	-0.006	0.004	-0.093	-0.045	0.210	0.187	0.436
K		1.000	0.448	0.021	0.290	0.012	0.728*	-0.117	0.079	-0.148	-0.037	0.040	0.074	-0.081	0.077	-0.012	0.002	0.055	0.205	-0.534*
Ca			1.000	0.175	0.851*	0.312	0.593*	-0.181	0.089	-0.113	-0.002	0.137	0.249	0.027	-0.159	-0.146	0.077	0.244	0.149	0.784*
Mg				1.000	0.272	0.331	-0.011	-0.026	0.141	-0.043	-0.084	-0.010	0.083	0.023	0.012	-0.149	0.069	-0.050	0.035	0.249
HCO ₃					1.000	0.190	0.342	-0.315	0.134	-0.182	0.062	0.185	0.322	0.156	-0.288	-0.031	0.216	0.301	0.033	0.596*
SO ₄						1.000	-0.003	0.171	0.188	0.134	-0.030	0.109	0.080	-0.014	-0.045	-0.054	-0.048	-0.057	0.143	0.108
Cl							1.000	-0.123	0.053	-0.103	-0.025	0.012	0.150	-0.087	0.026	-0.112	-0.021	0.160	0.248	0.654*
Fe								1.000	-0.094	0.189	-0.049	-0.100	-0.297	-0.230	0.192	-0.112	-0.155	-0.228	0.072	-0.201
Mn									1.000	0.117	-0.024	0.164	0.194	-0.041	-0.177	0.086	0.119	0.034	0.067	0.058
Cr										1.000	-0.143	-0.166	-0.120	0.083	0.074	-0.071	-0.098	0.041	-0.013	-0.074
Co											1.000	-0.007	0.100	-0.098	-0.080	-0.064	0.073	0.145	-0.078	-0.028
V												1.000	0.028	0.173	-0.198	-0.081	-0.091	0.007	0.116	-0.112
Cu													1.000	0.080	-0.197	0.185	0.395	0.294	-0.149	0.204
Zn														1.000	-0.222	-0.063	-0.091	0.278	-0.071	-0.036
NO ₃															1.000	-0.025	-0.216	-0.189	0.048	-0.132
NO ₂																1.000	0.165	0.129	-0.152	0.099
NH ₄																	1.000	-0.048	0.028	0.107
F																		1.000	-0.006	0.184
SiO ₂																			1.000	0.214
TDS																				1.000

* Significant at 95% confidence level

Table 3 : Correlation matrix for the magnesium type

	Na	K	Ca	Mg	HCO ₃	SO ₄	Cl	Fe	Mn	Cr	Co	V	Cu	Zn	NO ₃	NO ₂	NH ₄	F	SiO ₂	TDS
Na	1.000	0.931*	0.954*	0.882*	0.834*	0.947*	-0.379	0.237	0.298	0.068	-0.306	0.003	-0.238	-0.063	0.246	-0.163	-0.111	-0.170	-0.202	-0.177
K		1.000	0.957*	0.808*	0.764*	0.919*	-0.166	0.075	0.286	-0.088	-0.099	-0.005	-0.041	-0.091	0.127	-0.137	-0.073	-0.089	-0.064	0.007
Ca			1.000	0.876*	0.828*	0.964*	-0.162	0.129	0.225	0.026	-0.081	0.014	-0.020	-0.142	0.153	-0.199	-0.115	0.137	-0.151	-0.067
Mg				1.000	0.874*	0.956*	-0.465	0.283	0.448	0.166	-0.389	0.234	-0.278	-0.197	0.081	-0.207	-0.163	-0.144	-0.362	0.082
HCO ₃					1.000	0.813*	-0.251	0.032	0.239	0.048	-0.156	0.105	-0.029	-0.164	0.131	-0.115	-0.069	0.020	-0.313	-0.007
SO ₄						1.000	-0.354	0.252	0.369	0.111	-0.284	0.123	-0.212	-0.148	0.126	-0.202	-0.156	-0.173	-0.228	0.009
Cl							1.000	-0.525*	-0.424	-0.305	0.977*	-0.054	0.858*	-0.034	-0.179	0.065	-0.077	0.041	0.292	0.157
Fe								1.000	0.399	0.328	-0.427	0.200	-0.631*	-0.328	0.327	-0.336	-0.597*	-0.595*	-0.345	0.067
Mn									1.000	-0.037	-0.403	0.628*	-0.459	-0.241	-0.553*	-0.326	-0.327	-0.248	-0.270	0.416
Cr										1.000	-0.229	0.330	-0.434	0.265	0.259	-0.010	-0.290	-0.540*	-0.138	-0.265
Co											1.000	-0.016	0.844*	-0.128	-0.142	-0.011	-0.150	-0.027	0.220	0.190
V												1.000	-0.155	-0.337	-0.430	-0.406	-0.467	-0.305	-0.594*	0.487
Cu													1.000	-0.131	-0.144	0.139	-0.066	0.261	0.225	0.306
Zn														1.000	0.159	0.837*	-0.077	-0.255	0.723*	-0.307
NO ₃															1.000	0.239	-0.178	-0.253	-0.033	-0.370
NO ₂																1.000	-0.007	-0.169	0.685*	0.080
NH ₄																	1.000	0.892*	0.100	-0.410
F																		1.000	-0.912*	0.125
SiO ₂																			1.000	-0.116
TDS																				1.000

* Significant at 95% confidence level

Figure 5. Piper trilinear diagrams for the magnesium water type.

3.3.3 *The sodium potassium type*

This type forms a major group and is distributed widely in Sri Lanka, particularly around the central region. The north western and north central and the south eastern dry zones mainly contain this type of groundwater. From among the sub-types, the Cl type is predominantly found in these regions. Excessive evaporation and probably influence of salinity may have contributed to the prevalence of this water type. Table 4 shows the correlation matrix for the Na/K water type and Figure 6 illustrates the Piper trilinear diagrams.

3.3.4 *The non-dominant cation type*

As illustrated in Figure 3 the non-dominant cation type of water is distributed mainly at the periphery of the central highlands and some parts of the north central and southern regions. The HCO_3 and non-dominant anion sub-types predominate in these regions. Table 5 shows the correlation matrix for the non-dominant cation water type and Figure 7 illustrates the Piper trilinear diagrams.

3.3.5 *Effect of geology and climate on the chemistry of groundwater*

A closer study of the distribution patterns of the groundwater types in Sri Lanka reveals that the underlying geology and the climate affects the chemical quality of water to a great extent. The wet zone of Sri Lanka (See Figure 1) consists for the most part of non-dominant cation types and calcium - HCO_3 and non-dominant anion types. In the dry zone however, the Na/K type predominates and in this type of water the Cl sub-type is found covering vast areas of the dry zone. Evaporation under the strong drought conditions as prevailing in the dry zone of Sri Lanka results in the accumulation of sodium salts in the soil layers and this factor is largely responsible for the abundance of the Na/K type in the dry zone. Further, the northern parts of Sri Lanka are underlain by sedimentary limestones, as a result of which the calcium type of water predominates in these parts. Increasing salinity has been observed in areas closer to the shore-lines and in the Jaffna Peninsula in particular, this is commonly seen. The predominating anion in this type of water in the dry zone is Cl.

When one considers the topography, the central highlands have groundwater of the Ca - HCO_3 type and with decreasing elevation, merges into the non-dominant cation type. In the lowlands the Na/K type predominates. Thus a Ca $\rightarrow$ NDC $\rightarrow$ Na/K type of sequence is apparent with decreasing elevations from the highlands to lowlands. This sequence could well be due to the different geochemical mobilities of the elements concerned. Further, there are numerous shallow and deep seated fractures and lineaments within the central regions of Sri Lanka and these are mainly responsible for the migration of groundwater within the hardrock terrains.

Table 4 : Correlation matrix for the sodium/potassium type

	Na	K	Ca	Mg	HCO ₃	SO ₄	Cl	Fe	Mn	Cr	Co	V	Cu	Zn	NO ₃	NO ₂	NH ₄	F	SiO ₂	TDS
Na	1.000	0.077	0.634*	0.472*	0.635*	0.093	0.950*	-0.045	0.206	-0.320	0.269	0.007	0.322	0.217	-0.115	-0.248	0.193	0.218	0.123	0.400*
K		1.000	0.076	0.002	0.051	0.145	0.155	-0.123	0.020	-0.161	0.005	0.028	-0.100	-0.042	-0.134	-0.165	0.076	-0.307	0.039	-0.008
Ca			1.000	0.581*	0.894*	0.176	0.686*	-0.215	0.067	-0.305	0.155	-0.007	0.265	0.156	-0.162	-0.318	0.429*	0.219	0.169	0.496*
Mg				1.000	0.677*	0.277	0.519	-0.168	-0.041	-0.262	-0.176	-0.099	0.213	0.119	-0.214	-0.222	0.156	0.127	0.184	0.297
HCO ₃					1.000	0.064	0.661*	-0.213	0.012	-0.307	-0.067	-0.075	0.375	0.077	-0.131	-0.302	0.385	0.202	0.156	0.526*
SO ₄						1.000	0.076	-0.206	0.092	0.184	-0.175	0.074	-0.019	-0.102	-0.132	-0.154	0.047	0.044	0.194	0.004
Cl							1.000	-0.051	0.237	-0.308	0.301	0.001	0.340	0.268	-0.193	-0.272	0.167	0.247	0.128	0.445*
Fe								1.000	0.244	0.355	0.206	-0.009	-0.061	0.142	0.225	0.144	-0.107	-0.054	-0.147	0.154
Mn									1.000	-0.050	0.273	0.130	0.446*	0.268	0.053	-0.048	0.046	0.300	-0.103	0.002
Cr										1.000	-0.103	0.014	-0.259	0.098	0.102	0.255	-0.148	-0.114	-0.213	0.123
Co											1.000	0.241	0.181	0.213	-0.024	-0.125	0.083	0.250	-0.050	0.072
V												1.000	0.050	0.050	0.196	-0.119	-0.029	0.155	-0.046	-0.109
Cu													1.000	0.305	0.016	-0.186	0.076*	0.493	0.084	0.236
Zn														1.000	0.002	-0.020	0.061	0.322	0.050	0.005
NO ₃															1.000	0.199	0.030	-0.183	-0.024	-0.140
NO ₂																1.000	-0.127	-0.210	-0.133	-0.176
NH ₄																	1.000	-0.068	0.131	0.294
F																		1.000	-0.036	0.043
SiO ₂																			1.000	0.093
TDS																				1.000

* Significant at 95% confidence level

Figure 6. Piper trilinear diagrams for the sodium/potassium water type.

Table 5 : Correlation matrix for the non-dominant cation type

	Na	K	Ca	Mg	HCO ₃	SO ₄	Cl	Fe	Mn	Cr	Co	V	Cu	Zn	NO ₃	NO ₂	NH ₄	F	SiO ₂	TDS
Na	1.000	0.159	0.570*	0.331	0.497*	0.018	0.793*	-0.142	0.009	-0.116	0.024	-0.044	-0.001	-0.089	-0.143	-0.124	-0.042	0.103	0.140	0.307
K		1.000	0.548*	0.399	0.436	0.279	0.249	-0.096	-0.009	-0.030	0.214	0.097	0.260	-0.136	-0.039	-0.152	0.005	0.091	0.206	0.492
Ca			1.000	0.571*	0.856*	0.215	0.586*	-0.255	-0.050	-0.172	0.109	0.026	0.323	-0.189	-0.199	-0.224	0.120	0.240	0.436	0.760
Mg				1.000	0.691*	0.472*	0.290	-0.200	-0.049	-0.133	-0.064	0.043	0.114	-0.100	-0.207	-0.941*	0.209	0.183	0.328	0.509
HCO ₃					1.000	0.051	0.486*	-0.333	-0.118	-0.126	0.113	0.047	0.436	-0.098	-0.204	-0.134	0.250	0.304	0.374	0.780
SO ₄						1.000	0.023	0.062	+0.045	0.023	-0.055	-0.032	0.149	-0.117	-0.078	-0.153	0.004	-0.047	0.190	0.072
Cl							1.000	-0.165	-0.046	-0.096	0.228	-0.045	0.044	-0.021	-0.168	-0.158	-0.045	0.167	0.168	0.326
Fe								1.000	-0.024	0.167	-0.169	-0.005	-0.314	-0.254	0.215	-0.029	0.017	0.228	-0.096	-0.233
Mn									1.000	-0.003	-0.003	0.082	-0.098	-0.185	0.097	0.038	-0.204	-0.077	-0.105	-0.172
Cr										1.000	-0.149	-0.140	-0.065	0.142	0.188	-0.003	0.070	-0.027	-0.166	-0.063
Co											1.000	-0.042	0.066	-0.078	-0.168	-0.144	-0.006	0.055	0.170	0.202
V												1.000	0.199	0.001	0.174	-0.015	-0.004	0.091	0.036	-0.030
Cu													1.000	-0.065	-0.009	0.105	0.018	0.280	0.097	0.348
Zn														1.000	-0.006	-0.033	0.351	0.409	-0.290	-0.211
NO ₃															1.000	0.124	-0.104	-0.234	-0.234	-0.207
NO ₂																1.000	-0.187	-0.114	-0.120	-0.172
NH ₄																	1.000	0.114	0.071	0.017
F																		1.000	+0.052	0.166
SiO ₂																			1.000	0.452
TDS																				1.000

* Significant at 95% confidence level

NON DOMINANT CATION TYPE

3.3.6 Application in health

The delineation of areas of different water chemistry has applications in studies pertaining to human health and epidemiology. The effect of the chemistry of the groundwater on the health of the human population in Sri Lanka is of paramount importance due to the fact that the vast majority of the people use groundwater directly for their drinking and cooking purposes.

It is apparent from Figure 3 that the effect of Na, K and Cl is more pronounced in the dry zone areas as against Ca and non-dominant cation types in the wet zone. The people living in the dry zone regions are thus subjected to a different water chemistry than those living in other parts of Sri Lanka. The effect of water chemistry on the health of the population in Sri Lanka has been highlighted by Dissanayake *et. al.*⁶ and Dissanayake.⁴ From these studies it was revealed that there is a correlation between water hardness and the incidence of cardiovascular diseases. Areas underlain by groundwater with high water hardness appeared to have a low incidence of cardiovascular diseases as exemplified by the Jaffna Peninsula. On the other hand, certain regions in the wet zone where water hardness was low, had a higher incidence of cardiovascular diseases. Prior information on the chemical quality of the water of different areas helps in the delineation of disease prone regions. Among the other diseases dependent on the water quality are dental diseases such as dental fluorosis and tooth decay. Earlier studies^{3,5} have shown certain areas in Sri Lanka, particularly in the north central and eastern parts to contain anomalous fluoride concentrations in the groundwater. These areas coincided with a high incidence of dental fluorosis, particularly among school children.

4. Conclusions

The groundwater of Sri Lanka has been classified chemically and a map showing the distribution of the different water types prepared. The groundwater has been classified into 4 major types, namely Ca, Mg, Na/K and non-dominant cation types. The Ca-HCO₃ type is found predominantly in the wet zone of the central highlands and appear to be associated with the non-dominant cation types. In the dry zone, the Na/K type is abundant whereas in northern areas particularly in the Jaffna Peninsula, the Ca-Cl type is abundant. It is apparent that the distribution of the different groundwater types is markedly affected by the underlying geology and climatic factors. The map showing the distribution of the groundwater types has application in delineating areas susceptible to health hazards depending on the chemical composition of water.

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References

1. BROWN, E., SKOUGSTAD, M. W. & FISHMAN, M. J., (1970) *Methods for Collection and Analysis of Water Samples for Dissolved Minerals and Gases*. U.S.G.S. Publication. Book No. 5, Laboratory Analysis, Washington, D.C. 160 pp.
2. DAVIS, J., (1973) *Statistics and Data Analysis in Geology*. John Wiley and Sons, Inc. 216 pp.
3. DISSANAYAKE, C. B., (1974) Geochemical provinces and the incidence of dental diseases in Sri Lanka, *Sci. Tot. Environment* 13 : 47 – 53.
4. DISSANAYAKE, C. B., (1984) Environmental geochemistry and its impact on humans. In : *Ecology and Biogeography of Sri Lanka* (Ed. Fernando, C. H.) *Monographiae Biologicae Junk Publishers*. Netherlands 65 – 97.
5. DISSANAYAKE, C. B. & SENARATNE, A., (1981) Geochemical environments and the geographical distribution of some diseases in Sri Lanka. *Water Air and Soil Pollution*. 16, 267 – 276.
6. DISSANAYAKE, C. B., SENARATNE, A. & WEERASOORIYA, S. V. R. (1982) Geochemistry of well water and cardiovascular diseases in Sri Lanka. *Int. J. Env. Studies* 19: 195 – 203.
7. FISHMAN, M. J. & DOWNS, S. C. (1966) Methods for Analysis of Selected Metals in Water by Atomic Absorption Spectrophotometry. *U. S. Geol. Surv. Water Supply Paper* 1540 – C, 45 pp.
8. HEM, J. D. (1970) Study and Interpretation of the Chemical Characteristics of Natural Water, *U. S. Geol. Surv. Water Supply Paper* 1473 – C, 363 pp.
9. HILL, R. A. (1942) Salts in irrigation water. *Trans. Am. Soc. Civil Eng.* 107: 1478 – 1493.
10. LANGELIER, W. F. & LUDWIG, H. F., (1942) Graphic methods for indicating the mineral character of natural waters. *J. Am. Water Works Assoc.* 34, 335 – 352.

11. OLEA, R. A. (1975) Optimum mapping techniques using regionalized variable theory, Kansas Geol. Survey Series as Spatial Analysis No. 2, Univ. Kansa, Lawrence 137 pp.
12. PIPER, A. M., (1944) A graphic procedure in the geochemical interpretation of water analysis. *EOS Trans. Am Geophys. Union* 3, 914 – 923.
13. RIX, C. J., BOND, A. M. & SMITH, J. D., (1976) Direct determination of fluoride in sea water with a fluoride selective ion electrode by a method of standard additions. *Anal. Chem.* 48 : 1236 – 1239.
14. ROMANI, S., (1981) A new diagram for classification of natural water and interpretation of chemical analyses of data in quality of groundwater. Eds. *Quality of Groundwater*. Eds. : van Duijvenbooden, Glasbergen, P. and van Lelyrold, H. *Proc. Int. Symp. Noordwijkerbant, The Netherlands*. Elsevier 743 – 749 pp.
15. THORNTON, I. & PLANT, J., (1980) Regional geochemical mapping and health in the United Kingdom. *J. Geol. Soc. Lond.* 137 : 575 – 586.

Chemical Results of the Sampled Well Water: Ca - Cl Subgroup

Loca- tion No.	Ca ppm	Mg ppm	Na ppm	K ppm	HCO ₃ ppm	SO ₄ ppm	Cl ppm	TDS ppm	Total Hard- ness ppm in CaCO ₃	Total Fe ppb	Mn ppb	Total Cr ppb	Co ppb	Total V ppb	Cu ppb	Zn ppb	NO ₃ ppb	NO ₂ ppb	NH ₄ ppb	SiO ₂ ppm	F ppb	Topographic Sheet
33	60.13	5.55	2.29	20.14	61.0	44.18	70.00	195	164	2700	100	12	2	1	10	3	21,000	28	79	21	140	Alugama
86	6.00	1.21	2.84	3.51	12.8	3.36	11.00	112	27	110	42	17	7	8	20	217	600	111	11	14	700	Haputale
88	6.61	2.43	1.14	0.39	15.2	0.48	11.69	39	21	110	62	12	1	26	7	218	10	110	7	12	200	"
92	39.87	12.15	13.33	11.73	25.0	4.32	119.81	120	150	110	nd	2	17	4	13	217	3,000	310	12	2	2000	Buttala
100	20.04	0.04	12.85	15.64	43.9	0.43	41.99	101	52	3200	72	22	17	07	10	170	2,000	70	12	2	40	Avisawella
104	20.04	0.14	7.86	7.82	43.9	0.04	32.99	112	56	3200	73	20	1	3	12	120	6,000	122	11	8	430	"
117	20.04	8.48	1.52	0.39	19.5	0.33	41.99	103	85	1110	21	7	2	2	10	17	3,100	127	11	11	300	Hatton
197	88.07	12.10	45.98	31.68	183.0	1.53	170.00	300	270	3110	72	7	1	3	19	9	8,400	112	12	1	70	Dandagamuwa
273	100.20	12.08	45.97	5.86	128.7	5.25	210.00	850	300	70	100	12	10	7	32	22	4,600	10	312	12	40	Nalanda
404	220.00	3.68	68.96	67.26	348.9	4.80	460.00	920	700	1330	20	2	37	31	17	17	2,000	28	17	37	700	Medawachchiya
421	208.00	9.72	10.80	35.97	427.0	4.41	420.00	1700	920	170	27	3	1	7	21	28	2,000	22	627	41	750	Vavuniya
428	208.00	4.86	522.52	278.45	572.9	4.80	1200.00	1500	720	320	17	7	3	11	17	31	110	17	175	73	500	Mantai
442	260.50	11.91	183.90	28.94	616.8	47.07	412.00	1011	700	400	17	11	8	1	125	80	1200	12	137	31	2800	Padaviya
452	260.50	11.91	344.82	283.92	446.6	34.58	1000.00	2200	700	400	82	2	11	20	21	21	10,610	120	175	75	1500	Tunukkai
453	320.60	11.91	413.79	237.38	427.0	5.76	1200.00	2107	850	170	35	7	27	11	19	34	nd	72	175	60	500	Iranamadu
454	200.40	11.91	275.86	228.39	305.0	15.36	1010.00	2100	810	700	30	3	2	12	14	37	nd	90	170	75	1000	"
455	240.40	97.00	531.72	403.98	610.1	15.36	1560.00	4100	1000	170	30	2	7	1	13	32	nd	91	100	60	750	"
456	220.00	60.78	206.89	183.71	305.0	240.13	700.00	1512	800	460	17	2	1	1	20	28	200	30	17	92	500	Murukun
457	200.40	97.00	758.62	438.40	610.1	96.06	1780.00	1500	900	640	22	2	2	3	10	45	1,000	17	27	37	750	"
458	308.01	72.93	857.58	177.12	610.1	18.25	1920.00	1600	820	820	27	1	3	7	15	27	1,200	27	21	19	1000	"
483	76.75	24.31	27.58	15.64	60.3	63.40	169.00	320	290	800	74	3	1	1	32	28	1,700	120	102	22	321	Kala Oya

Chemical Results of the Sampled Well Water: Ca - SO₄ Subgroup

Loca- tion No.	Ca ppm	Mg ppm	Na ppm	K ppm	HCO ₃ ppm	SO ₄ ppm	Cl ppm	TDS ppm	Total Hard- ness ppm in CaCO ₃	Total Fe ppb	Mn ppb	Total Cr ppb	Co ppb	Total V ppb	Cu ppb	Zn ppb	NO ₃ ppb	NO ₂ ppb	NH ₄ ppb	SiO ₂ ppm	F ppb	Topographic Sheet
26	120.08	40.08	45.97	29.33	183.0	344.75	20.00	430	400	3200	122	7	4	20	6	22	110	38	32	31	100	Ambalantota
76	60.12	6.68	28.25	7.63	60.4	144.09	27.00	272	178	870	94	10	7	17	51	100	7,000	27	11	7	400	Ratnapura
120	6.09	0.01	5.6	3.91	0.6	12.96	7.00	114	67	1100	20	7	1	1	61	280	700	900	10	22	190	Hatton
126	20.04	2.41	2.29	2.69	19.5	3.41	12.00	118	60	110	21	3	3	2	10	317	5,000	117	7	18	20	Nuwara Eliya
407	218.83	3.73	25.51	35.97	361.1	46.68	20.00	1500	700	170	24	2	122	117	10	22	210	27	32	22	700	Horowprana

168	62.32	2.43	22.98	11.63	298.9	44.18	20.99	110	256	1000	20	11	43	10	44	212	7,500	12	310	10	100	Kandy
169	40.08	7.74	9.19	1.07	122.0	32.18	13.99	180	132	2700	42	7	141	7	45	111	8,000	70	331	1	100	"
170	60.12	12.10	22.98	1.79	183.0	46.58	38.00	-	200	770	70	7	142	3	40	71	2,000	27	127	7	150	"
171	40.08	5.32	6.89	1.34	122.0	23.53	9.99	200	122	7000	90	3	17	2	42	200	1,000	78	140	8	120	"
172	20.04	9.41	1.83	0.71	61.0	39.38	1.99	122	89	2100	210	12	3	4	37	317	2,000	70	60	14	20	Hanguranketa
173	40.08	5.29	0.45	2.00	107.5	44.18	1.99	122	122	1700	72	12	13	14	20	410	3,000	27	128	40	170	"
174	60.12	4.82	10.12	17.20	183.0	19.06	17.58	170	170	2120	172	17	3	117	12	317	200	70	420	112	320	"
175	60.12	4.82	10.12	17.20	183.0	19.06	17.58	170	2120	700	43	14	2	312	12	218	1,200	72	440	11	100	"
176	100.00	12.08	45.97	7.23	304.0	96.06	41.98	300	300	720	43	14	2	312	12	218	1,200	72	440	11	100	"
177	40.08	2.40	22.98	15.01	128.1	34.58	17.00	121	110	110	72	15	4	412	13	320	7,100	74	312	111	990	"
178	60.12	4.82	22.98	3.20	183.0	34.58	27.00	117	170	1100	45	10	42	1	17	327	3,000	12	127	22	120	"
179	42.08	3.61	22.98	4.25	128.1	34.58	27.99	200	120	120	43	10	42	1	20	227	700	120	320	110	320	"
187	86.16	9.10	22.98	32.05	250.7	2.79	69.99	470	238	170	70	2	4	72	173	27	800	320	1000	12	1500	Tirukovil
188	100.00	5.30	6.62	7.82	305.0	1.59	71.99	500	272	120	112	3	2	7	42	28	920	470	2110	13	1200	"
192	120.24	24.10	22.98	6.41	427.0	4.31	37.00	540	400	130	102	12	7	38	170	72	200	227	2700	17	2300	"
200	60.12	4.80	45.98	2.74	183.0	0.81	80.00	175	170	620	77	67	40	1	12	22	9,200	22	17	1	90	Dandaganuwa
201	60.12	5.30	16.18	3.91	147.6	3.88	59.99	170	172	120	81	4	42	1	13	21	6,000	17	43	2	10	"
202	60.12	5.30	22.99	38.33	183.0	2.79	60.00	200	173	170	82	17	27	3	11	17	6,400	77	41	11	620	"
203	60.12	1.16	22.99	7.43	183.0	2.79	19.99	200	155	110	85	3	31	2	19	22	1,000	27	24	3	730	"
206	40.08	7.22	22.99	9.38	142.1	1.34	50.00	200	120	430	62	2	17	1	22	30	7,000	7	71	3	120	"
207	40.08	6.51	22.99	5.08	122.0	2.09	40.00	250	127	200	75	7	22	1	29	22	8,500	7	13	4	190	"
208	40.08	8.92	10.11	15.64	123.0	2.86	30.00	158	137	560	60	3	17	1	27	31	10,000	3	27	2	300	"
211	40.08	4.81	23.91	0.78	122.0	1.24	39.99	170	120	880	67	12	1	17	20	27	11,000	417	17	3	100	Kurunegala
214	60.12	5.28	9.88	15.64	183.0	1.63	29.99	170	172	720	64	7	117	20	52	34	7,200	317	127	2	200	"
221	40.08	3.13	2.29	29.21	122.0	12.39	30.00	170	113	770	58	7	1	22	53	28	4,000	713	31	8	40	"
230	40.08	12.12	2.29	18.77	115.9	53.31	20.00	170	97	770	43	5	7	2	72	74	10,000	22	17	11	10	"
231	40.08	4.83	2.29	29.21	122.0	19.11	30.63	170	97	750	40	5	3	2	71	75	10,000	21	22	12	10	"
232	60.42	34.31	22.98	7.23	286.7	63.40	17.00	150	266	820	41	17	3	412	13	341	300	78	141	21	20	Rangala
233	74.45	12.15	2.29	19.12	244.0	34.10	20.99	320	236	910	42	7	17	312	17	313	270	17	114	2	130	"
234	20.04	1.20	2.29	6.41	61.0	4.32	9.00	170	55	880	70	14	1	217	37	337	10	29	52	3	290	"
236	100.02	2.61	2.29	18.92	263.5	48.03	17.00	170	261	720	90	3	3	412	21	412	880	28	145	7	90	"
237	140.28	9.87	2.29	6.25	415.4	44.18	11.99	120	291	720	74	2	1	313	10	320	1,000	74	54	4	170	"
238	68.82	24.31	2.29	39.10	300.1	48.03	17.00	170	272	710	92	3	1	117	20	317	1,000	120	42	32	270	"
239	100.20	4.55	2.29	26.07	305.0	18.01	27.00	170	269	620	92	3	1	312	10	217	920	70	43	3	90	"
240	80.86	12.15	22.98	0.04	298.0	35.06	21.99	1200	252	110	90	2	3	412	17	218	620	170	47	31	190	"
244	68.01	36.46	0.22	0.39	311.7	44.18	11.99	1200	320	770	110	8	1	17	74	115	200	920	427	27	130	Maha Oya

246	40.08	24.19	0.22	302.6	20.17	21.99	720	300	150	117	13	62	21	113	400	470	528	4	20	Topographic
248	120.24	4.78	2.29	24.32	329.0	101.34	41.99	730	320	700	120	17	1	27	88	737	422	3	320	Sheet
250	70.03	243.31	2.29	0.25	272.0	61.43	10.00	700	290	620	120	10	3	17	61	920	412	17	370	Maha Oya
251	220.20	12.15	45.97	9.19	616.8	84.58	120.00	420	600	440	120	4	11	42	61	72	270	2	620	"
257	148.11	24.31	413.79	12.90	385.0	63.40	127.00	700	470	110	70	3	2	41	120	74	5,000	140	270	Kalmunai
268	80.16	4.08	22.08	23.62	250.7	61.04	20.00	412	217	630	120	15	13	7	27	10	5,000	512	18	"
270	40.08	4.09	22.98	9.38	122.6	39.63	30.00	317	117	400	122	7	11	1	41	19	1,000	522	12	Wariyapola
276	96.05	24.31	2.29	29.17	206.2	85.49	30.00	520	340	130	74	20	42	1	39	17	6,000	21	312	"
280	128.11	12.15	2.98	33.63	285.0	113.94	20.00	370	370	810	80	20	7	1	42	72	4,600	26	515	Nalanda
282	40.08	12.13	2.29	3.91	128.7	34.61	12.99	350	150	30	120	22	17	32	17	9,200	22	312	17	"
284	80.16	2.38	2.29	34.61	194.9	63.46	23.99	370	210	70	120	21	12	2	38	121	9,400	21	532	"
285	80.16	4.80	2.29	34.10	224.0	44.27	16.00	350	220	80	140	22	27	7	42	18	4,600	22	737	"
290	100.20	12.00	0.22	0.39	199.1	105.18	20.00	390	300	210	20	10	77	1	92	517	11,700	130	452	Elahera
291	88.43	24.31	2.29	0.86	305.0	59.61	10.00	420	321	610	76	20	22	1	71	417	6,000	117	132	"
292	60.12	6.03	2.29	7.27	147.0	63.46	2.00	395	175	310	73	20	27	7	71	217	700	113	437	"
293	60.12	5.30	22.98	34.33	183.0	101.44	7.00	320	172	710	75	22	12	3	78	312	10,000	122	53	"
296	96.79	24.31	2.29	25.10	305.0	87.98	27.00	400	342	270	121	22	1	7	62	320	10,000	142	123	"
297	84.02	24.31	2.29	24.34	377.8	63.46	13.99	390	360	110	122	14	7	1	82	412	3,100	47	417	"
298	97.66	24.31	22.98	10.55	372.7	37.50	41.99	410	341	110	100	10	8	7	61	310	2,700	52	312	"
301	40.08	24.19	2.29	3.83	226.9	101.34	27.00	342	320	170	110	15	1	1	67	325	10	67	74	"
303	116.00	12.15	2.29	30.66	305.0	101.44	20.00	500	340	210	100	2	17	227	92	320	10	9	49	Rukam
312	140.20	12.03	68.96	13.35	433.8	47.55	119.99	427	310	400	600	120	10	22	732	97	31	430	18	"
325	120.24	2.35	91.95	15.72	372.1	53.31	119.99	700	210	70	70	12	32	32	122	418	110	38	21	Polonnaruwa
330	80.16	2.43	68.96	7.39	244.0	9.36	130.00	700	310	70	70	12	32	32	122	418	110	38	21	"
332	120.24	2.30	68.96	35.97	366.0	34.58	118.57	600	345	110	38	18	17	17	71	410	110	40	32	"
333	120.24	10.81	91.95	31.28	366.0	212.89	169.97	600	345	110	38	18	17	17	71	410	110	40	32	"
334	120.24	11.30	68.96	17.98	372.7	15.70	139.98	680	347	100	20	17	20	2	93	317	210	41	31	"
337	80.16	7.78	252.87	23.46	189.7	48.03	429.98	293	283	140	240	10	112	411	163	210	10,700	31	127	Vakneri
355	80.16	7.29	2.29	28.94	244.0	44.66	18.00	386	230	1720	27	1	413	212	20	22	12,000	42	127	"
356	140.28	0.40	2.29	16.81	427.0	5.28	15.98	653	352	3000	23	3	27	117	18	10	270	17	237	Anuradhapura
357	120.34	1.38	68.96	16.42	372.7	34.58	60.54	689	306	120	30	2	117	12	22	10	12,100	51	133	"
358	120.24	19.32	45.97	28.94	427.0	24.49	100.00	442	380	110	21	2	27	17	21	12	6,000	22	147	"
359	100.20	4.25	91.95	5.47	311.7	15.36	143.99	460	268	610	22	3	28	22	23	120,000	27	132	37	"
361	140.24	23.23	68.96	14.07	488.1	13.36	139.98	657	447	70	25	17	22	28	18	720	820	17	162	"
362	100.20	13.28	68.96	9.38	366.0	34.58	39.98	608	305	1000	21	11	27	13	21	340	720	92	337	"

363	60.12	9.36	22.98	14.07	183.0	34.56	39.98	474	189	2000	22	10	22	12	29	170	4,000	95	920	30
364	84.06	12.18	22.98	19.53	311.7	15.36	39.98	373	260	370	27	2	27	17	27	122	9,200	93	172	31
366	80.16	6.68	45.97	9.77	244.0	26.41	80.00	354	228	270	24	7	111	27	17	180	110	37	415	21
368	160.32	1.36	68.96	28.94	494.8	15.36	124.59	659	406	110	320	20	117	14	42	170	400	43	413	17
369	160.32	2.33	45.97		494.8	15.36	66.11	753	410	420	72	21	27	17	31	720	720	47	213	21
						</														

Chemical Results of the Sampled Well Water Ca - NDA Subgroup

Lac-	Ca	Mg	Na	K	HCO ₃	SO ₄	Cl	TDS	Total Hard-	Total Fe	Mn	Total Cr	Co	Total V	Cu	Zn	NO ₃	NO ₂	NH ₄	SiO ₂	F	Topographic Sheet
No.	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ness	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppb	
7	80.16	7.23	25.50	4.34	122.0	136.50	70.00	384	280	2730	12	21	17	7	11	18	7,000	18	81	47	40	Ambalangoda
8	63.64	12.16	21.20	4.34	122.0	29.60	22.10	298	209	3700	120	20	22	13	12	23	4,000	12	80	32	60	"
9	100.20	9.17	22.90	0.43	116.0	99.20	70.00	302	288	3000	110	23	21	2	17	22	7,000	22	78	11	80	"
10	108.07	24.31	22.90	3.36	183.0	196.10	50.00	340	370	2710	60	20	12	50	61	7	7,100	12	82	28	100	Morawaka
11	100.20	3.07	22.90	4.30	189.8	106.21	70.00	327	313	3000	63	22	12	40	36	3	7,000	21	87	27	60	"
15	88.02	36.47	22.90	0.39	128.8	187.30	90.00	410	370	7260	73	12	22	40	2	27	11,000	51	37	62	70	Matara
16	100.23	38.79	22.90	0.39	193.9	196.90	70.00	411	410	6000	70	27	17	28	17	13	70	72	17	67	20	"
37	40.08	4.76	2.30	31.36	91.5	27.41	38.00	170	112	2700	122	12	1	18	11	14	11,200	71	17	21	90	Alurgama
38	62.12	7.95	22.90	4.82	140.3	53.31	43.00	278	175	2190	160	17	1	100	11	11	11,000	27	101	77	20	"
39	62.12	8.75	2.30	3.29	104.9	34.61	44.12	180	172	3000	27	22	1	1	10	10	10,000	22	200	31	120	"
48	60.12	3.94	45.90	20.41	132.4	63.40	79.01	172	160	110	112	9	4	127	10	72	110	120	12	44	670	Katragama
58	80.16	6.00	22.90	24.63	183.03	82.61	50.01	440	225	400	122	7	7	320	70	45	1,000	170	3	32	520	Yala
79	5.60	1.21	2.80	1.48	12.8	5.31	7.01	28	29	110	27	12	22	1	10	217	3,000	71	17	7	210	Haputale
82	8.80	1.21	5.70	1.56	12.8	10.11	13.11	40	27	110	41	2	2	17	10	218	900	21	11	1	400	"
89	8.80	0.12	1.60	0.39	12.8	0.52	11.12	47	27	80	43	20	17	21	9	417	1,000	110	10	13	560	"
108	40.08	0.65	9.10	3.91	61.0	6.11	27.02	152	127	3000	78	19	2	127	17	420	1,110	28	12	2	380	Awissawella
113	11.60	0.48	1.80	0.78	31.7	2.42	2.01	98	49	720	32	8	2	1	82	71	3,200	270	10	3	170	Hatton
128	40.08	5.31	13.70	0.42	61.0	4.43	40.01	172	122	720	72	10	42	1	27	22	820	12	11	27	220	Passara
129	40.08	3.13	22.90	0.36	104.9	4.74	72.11	153	113	110	70	20	4	1	21	13	110	70	2	37	10000	"
140	60.12	2.39	22.90	34.19	129.3	4.47	72.11	122	100	5000	42	13	3	117	10	92	10,000	122	9	2	270	Campaha
142	40.08	4.83	2.30	1.56	61.1	4.43	22.01	117	120	1220	18	10	3	110	7	94	7,000	320	11	3	490	"
144	60.12	12.10	9.90	3.91	117.1	6.82	41.02	211	200	3110	13	12	1	17	3	95	3,200	110	78	3	210	"
146	42.28	3.48	11.71	3.91	61.0	5.81	28.11	204	120	1700	21	14	7	1	8	71	11,000	320	12	7	390	"
147	40.08	2.64	22.91	3.87	122.0	4.31	72.00	170	111	4000	71	13	8	1	10	70	17,000	73	10	1	420	"
184	60.12	11.90	22.91	5.87	263.6	192.10	100.00	470	400	620	112	10	2	122	69	142	600	337	922	98	1700	Nigala
243	140.28	12.05	68.90	16.81	263.6	192.10	100.00	500	400	410	76	18	37	2	43	120	2,600	22	718	12	30	Maha Oya
275	100.00	36.46	0.21	0.39	196.5	101.30	100.00	540	400	410	111	13	22	27	87	317	4,600	117	137	14	40	Elahera
288	100.00	36.46	22.91	12.90	254.4	150.11	72.00	400	400	110	111	13	22	27	87	317	4,600	117	137	14	40	Elahera
473	66.73	36.47	2.29	nd	190.3	115.75	31.97	422	317	610	142	10	118	1	19	27	3,100	7	62	11	1100	Kala Oya
477	79.36	12.16	183.90	8.21	208.6	63.40	300.00	400	248	170	72	01	13	11	31	18	3,200	11	33	31	400	"
478	91.26	12.16	45.97	27.38	253.2	34.58	119.99	353	278	270	71	12	2	17	30	27	2,100	12	37	38	100	"

Chemical Results of the Sampled Well Water Mg - SO₄ Subgroup

Loca- tion No.	Ca ppm	Mg ppm	Na ppm	K ppm	HCO ₃ ppm	SO ₄ ppm	Cl ppm	TDS ppm	Total Hard- ness ppm in CaCO ₃	Total Fe ppb	Mn ppb	Total Cr ppb	Co ppb	Total V ppb	Cu ppb	Zn ppb	NO ₃ ppb	NO ₂ ppb	NH ₄ ppb	SiO ₂ ppm	F ppb	Topographic Sheet
12	60.12	45.63	2.52	0.39	61.0	187.50	70.00	370	320	2210	58	18	22	38	41	2	820	27	48	11	420	Morawaka
459	200.40	308.77	91.95	41.06	915.0	1200.00	1.98		1770	2000	72	12	1	30	25	50	2000	60	14	3	430	Tibulkettiya
460	601.20	611.71	206.89	233.08	1220.2	3746.39	10.00		4170	1600	77	14	3	35	24	75	3000	48	92	8	460	"
462	26.37	36.46	22.98	17.43	122.0	144.09	27.00	490	216	1450	83	12	4	48	22	88	110	45	11	13	490	"
463	39.87	72.93	22.98	12.63	183.0	192.12	81.99	450	400	1250	77	12	17	75	23	80	820	45	12	2	490	"
465	36.07	253.58	22.98	13.19	732.1	480.30	7.00	1005	1044	1450	79	19	2	75	23	77	1700	60	22	3	530	"
466	85.37	243.13	22.98	14.86	274.5	960.61	10.00	1695	1214	1600	72	17	1	80	24	60	700	65	2	1	505	"
467	75.15	121.56	45.97	69.61	305.0	516.33	10.06	1712	688	2050	105	8	3	48	20	48	600	65	16	10	510	"
468	89.37	243.13	22.98	29.78	305.0	982.70	27.00	1462	1224	2000	90	7	2	30	20	30	600	65	1	14	800	"

Chemical Results of the Sampled Well Water Mg - Cl Subgroup

Loca- tion No.	Ca ppm	Mg ppm	Na ppm	K ppm	HCO ₃ ppm	SO ₄ ppm	Cl ppm	TDS ppm	Total Hard- ness ppm in CaCO ₃	Total Fe ppb	Mn ppb	Total Cr ppb	Co ppb	Total V ppb	Cu ppb	Zn ppb	NO ₃ ppb	NO ₂ ppb	NH ₄ ppb	SiO ₂ ppm	F ppb	Topographic Sheet
148	6.75	24.31	22.98	2.02	121.4	4.41	17.00	200	117	2320	17	14	3	3	12	77	7000	70	12	7	420	Gampaha
180	7.95	24.31	16.17	7.82	128.1	19.11	32.00	110	120	720	44	16	3	1	12	410	2100	127	221	30	130	Hanguranketa
186	19.92	60.50	9.19	12.51	305.0	3.57	28.00	152	300	170	42	7	3	7	70	27	270	47	792	7	3780	Nilgala
411	100.20	8.74	0.22	39.10	434.4	3.45	170.00	1510	610	120	28	7	47	27	270	70	1270	82	17	17	1000	Horowpatana

Chemical Results of the Sampled Well Water Na + K/Cl Subgroup

Loca- tion No.	Ca ppm	Mg ppm	Na ppm	K ppm	HCO ₃ ppm	SO ₄ ppm	Cl ppm	TDS ppm	Total Hard- ness ppm in CaCO ₃	Total Fe ppb	Mn ppb	Total Cr ppb	Co ppb	Total V ppb	Cu ppb	Zn ppb	NO ₃ ppb	NO ₂ ppb	NH ₄ ppb	SiO ₂ ppm	F ppb	Topographic Sheet
3	64.02	21.32	160.90	4.34	153.8	20.20	320.00	372	250	3710	78	17	27	17	11	21	720	72	12	32	80	Ambalangoda
4	88.07	12.16	163.50	4.97	122.0	63.40	330.00	340	270	2800	93	10	10	12	12	12	2700	18	92	37	90	"
5	69.22	24.31	296.80	39.10	61.0	381.80	370.00	371	273	2100	122	20	11	27	13	17	1820	70	17	30	70	"
23	66.03	27.90	273.60	16.03	61.0	188.00	450.00	317	365	1710	140	3	1	10	2	18	310	110	20	40	1720	Ambalangoda
28	216.00	60.12	919.00	15.64	555.8	53.31	1560.00	692	617	110	100	1	17	2	10	50	720	70	27	14	1700	Hambantota
29	126.00	120.00	1333.00	35.19	616.8	101.34	2150.00	617	617	210	112	7	12	2	11	72	710	72	21	31	1800	"
31	8.39	10.4	68.96	4.47	67.7	5.28	100.00	82	46	3100	72	7	7	11	32	7	40,000	9	100	17	20	Alugama
32	20.04	8.79	22.93	29.72	44.5	19.69	73.00	89	72	3200	63	10	3	7	12	2	41,000	17	111	22	130	"
47	60.12	10.34	114.00	23.69	61.0	96.06	217.00	137	176	200	111	8	2	17	10	71	210	72	41	27	730	Rakvana
50	60.12	5.55	712.00	18.38	128.7	5.28	1153.00	170	164	400	52	17	3	145	21	173	320	92	11	43	600	"
51	60.12	11.94	2252.00	38.32	183.0	27.37	2514.00	192	180	1200	58	1	2	142	20	232	6,000	17	7	41	610	"
52	87.99	100.00	1241.00	32.45	250.7	101.34	2091.00	478	470	300	74	3	1	140	9	60	10	111	2	31	700	"
55	83.96	60.12	183.00	17.09	311.7	101.34	298.00	375	360	170	67	1	17	127	32	71	110	20	11	42	600	"
56	20.04	40.04	114.00	5.47	61.0	53.31	178.00	501	100	700	120	2	1	200	70	25	920	100	7	71	720	Yala
59	9.88	4.86	45.98	19.98	25.6	5.30	100.00	248	42	3200	78	21	1	11	10	70	12,000	170	12	13	120	Panadura
60	40.08	4.82	68.97	15.25	85.4	48.00	120.00	399	92	3210	120	30	3	2	11	70	13,000	780	13	13	100	"
61	8.00	3.65	68.97	28.94	37.8	34.50	110.00	242	35	4000	122	35	8	7	22	20	12,000	520	7	12	10	"
62	20.04	1.93	68.97	37.04	61.0	34.50	120.00	370	58	2700	123	27	2	7	9	32	10,000	419	7	24	90	"
63	11.20	4.86	22.99	38.33	51.8	5.30	70.00	252	48	3200	123	28	12	8	7	31	12,000	229	2	1	70	"
64	10.80	1.21	56.51	4.69	11.2	4.80	97.00	257	47	2700	128	21	12	8	2	32	12,000	140	2	2	170	"
65	4.78	2.43	56.51	16.87	1.8	9.60	100.00	292	32	3700	125	21	17	7	2	17	12,000	232	7	14	200	"
66	8.39	4.86	56.51	26.63	6.1	9.60	100.00	292	32	2700	124	22	3	7	3	94	12,110	370	11	3	110	"
67	19.83	2.06	2.82	2.34	54.9	1.92	10.00	471	41	7000	77	19	2	10	22	92	21,000	170	17	42	130	"
69	10.40	3.64	28.25	9.60	1.2	3.36	70.00	274	52	3780	91	20	7	11	13	93	10,000	920	12	13	70	"
70	10.62	4.37	28.25	22.05	4.2	0.96	82.00	274	41	3780	92	20	8	10	14	91	20,000	720	21	31	170	"
80	2.00	1.19	5.65	1.90	26.1	0.48	12.00	75	19	720	22	13	1	1	10	410	110	71	10	13	700	Haputale
90	20.04	0.60	91.95	4.94	43.9	0.52	170.00	75	75	80	70	1	2	17	17	418	2,000	1000	2	31	270	Birtalla
91	12.00	0.48	92.71	39.10	22.5	0.09	200.00	50	120	120	71	7	3	7	12	315	780	720	7	3	1000	"
98	2.79	0.36	68.96	25.53	61.0	2.92	88.00	22	22	120	100	32	21	721	7	122	20,000	40	72	2	100	Colombo
101	20.04	1.66	45.97	3.16	56.7	4.80	71.00	190	94	3200	72	36	3	17	7	140	2,000	172	17	15	520	Arissawella
106	12.00	0.24	22.98	6.22	43.3	0.52	40.00	142	35	2370	77	27	8	7	15	210	1,000	43	11	7	410	"

Topographic Sheet	Passara	Puttuvil	Gampaha	Kandy	Hanguranketa	Chilaw	"	Dandagamuwa	Kurunegala	"	"	"	Kalmunai	Attulu Oya	Wariyapola	"	Rukam	Batticaloa	Puttalam	Dambulla	"	Poonnaruwa
30	20.04	1.44	68.96	38.57	61.0	3.45	120.00	143	56	330	70	13	47	2	22	27	720	131	11	48	2780	
32	51.22	12.15	137.00	4.70	155.5	4.41	200.00	240	178	130	70	8	13	22	100	13	110	120	42	12	200	
36	27.98	12.15	91.95	36.68	83.6	5.85	170.00	270	112	440	72	10	112	21	8	21	170	71	80	42	210	
40	40.08	4.10	5.97	20.02	18.9	9.60	90.00	290	112	2120	27	20	1	8	7	13	3,100	41	11	2	270	
52	64.44	12.15	91.95	25.27	183.0	5.81	165.00	170	211	1800	95	10	22	12	60	42	350	530	120	3	100	
74	40.08	2.89	68.96	2.85	73.8	47.05	110.00	122	89	2100	210	12	3	4	37	317	2,000	70	60	14	20	
94	60.12	12.00	250.00	387.56	176.9	3.88	720.00	120	200	1120	112	7	47	7	11	27	3,000	17	1010	12	110	
96	40.08	4.80	183.00	32.46	77.4	2.79	320.00	170	170	3210	112	7	37	31	22	17	3,000	12	1277	7	100	
99	40.08	12.10	91.00	32.06	183.0	1.63	170.00	150	150	6820	78	7	32	2	11	10	5,000	70	22	12	170	
99	40.08	12.10	91.00	37.86	115.9	3.57	180.00	90	90	870	62	7	32	2	11	10	5,000	70	22	12	170	
100	20.04	9.65	114.00	3.13	61.0	3.09	180.00	108	108	190	70	8	2	27	82	37	4,400	422	32	11	100	
113	40.08	2.88	116.00	19.95	122.0	0.78	200.00	112	112	120	66	7	1	22	73	37	4,400	422	32	11	100	
116	60.12	12.82	91.00	28.70	183.0	34.58	180.00	120	120	710	70	3	17	32	51	26	5,800	218	27	21	200	
123	40.08	4.83	160.00	2.34	122.0	19.11	250.00	120	120	77	120	50	16	21	37	52	6,600	17	17	52	110	
126	20.04	6.54	45.00	10.55	61.0	25.88	80.00	127	77	120	41	8	22	41	60	73	6,600	17	17	52	110	
125	20.04	6.54	114.00	17.98	67.7	34.58	190.00	nd	540	440	100	10	02	31	143	22	10,100	217	720	17	720	
125	156.00	36.54	643.00	14.07	1043.9	5.30	310.00	700	370	720	112	18	21	7	62	10	6,000	17	420	110	500	
156	12.81	12.15	137.00	72.39	268.0	101.34	240.00	640	124	610	120	5	21	2	61	20	2,700	9	572	127	700	
158	40.08	5.81	137.00	32.65	26.3	25.81	230.00	700	127	110	111	3	21	2	73	17	3,100	7	720	21	1000	
159	40.08	6.54	137.00	19.08	122.0	47.64	170.00	470	150	110	111	3	21	2	73	17	3,100	7	720	21	1000	
160	40.08	12.12	91.00	31.20	122.0	34.58	310.00	571	154	20	112	10	17	2	47	12	4,200	47	12	110	320	
161	60.12	0.93	206.00	19.47	189.7	44.18	370.00	1082	59	40	120	13	32	3	79	13	6,400	122	17	2	410	
162	20.04	2.17	252.00	11.37	67.7	67.72	520.00	540	316	710	140	12	3	2	42	17	800	270	17	12	430	
262	86.45	24.31	275.00	38.32	195.8	58.17	420.00	300	420	560	110	2	11	22	121	141	20,000	3	90	27	3200	
264	88.00	34.46	321.00	18.77	427.0	63.46	414.00	300	400	110	117	2	13	227	172	141	110	72	12	17	3100	
308	100.00	32.15	229.00	6.67	304.4	58.17	410.00	400	490	720	122	7	17	113	170	132	10,700	20	18	21	3120	
309	176.00	12.15	252.00	31.67	536.3	34.58	410.00	440	440	470	20	1	22	117	170	131	21,000	17	27	22	980	
310	156.00	12.15	229.00	19.16	427.0	48.99	120.00	470	320	110	120	3	27	117	180	32	22,000	120	1142	47	670	
313	120.00	4.78	758.00	0.78	311.7	48.99	120.00	500	300	120	200	2	117	217	146	142	21,000	77	1224	22	700	
314	100.00	12.15	482.00	13.68	300.1	101.34	720.00	500	300	120	200	2	117	217	146	142	21,000	77	1224	22	700	
316	287.00	48.62	919.00	20.72	630.8	106.14	1642.00	3137	918	360	160	10	2	3	47	71	2,000	90	1400	14	450	
317	410.00	91.05	1149.00	18.38	1226.9	63.40	2004.00	3812	1376	320	240	11	3	2	43	82	2,000	20	1700	13	700	
322	80.00	6.56	183.00	5.47	244.0	44.66	280.00	708	227	360	220	17	1	3	27	17	4,800	97	32	8	300	
323	80.00	5.10	298.00	11.34	244.0	44.18	444.00	720	221	1100	170	2	7	2	24	73	7,800	92	14	2	130	
324	100.00	5.95	252.00	37.57	305.0	15.36	430.00	700	975	760	74	3	3	27	27	72	11,000	27	17	3	400	
326	100.00	4.74	137.00	15.55	196.4	44.18	310.00	300	320	720	20	22	117	28	72	310	110	27	22	7	8210	

Topographic Sheet	2 5020	28	17	210	422	39	132	17	72	30	342	340	410.00	24.97	257.4	22.68	206.00	10.08	120.00
Poimnarua	17	332	71	210	172	13	142	17	120	340	232	430.00	48.03	189.7	23.46	206.00	7.78	80.16	
Vakaneri	27	370	71	27	1,000	9	19	27	100	170	720	1500	20.17	629.6	25.81	206.00	48.62	208.00	
Kalpitiya	17	437	17	2,100	32	3	18	32	70	370	720	1720.00	1400	20.17	666.2	25.81	36.46	220.00	
Anuradhapura	17	437	17	2,100	32	42	417	19	18	370	720	1720.00	1400	20.17	666.2	25.81	80.00	220.00	
"	34	400	54	22,000	32	42	417	19	18	370	720	1720.00	1400	20.17	666.2	25.81	5.03	82.00	
"	27	5070	37	7,000	32	127	22	22	70	321	3110	22	436.00	5.28	866.0	29.87	48.62	82.00	
Kaudulla	17	475	17	610	32	22	32	42	70	370	720	1720.00	542	34.58	427.0	29.87	36.46	67.00	
"	21	1500	37	1,000	127	18	13	62	18	370	720	1720.00	542	34.58	427.0	29.87	5.03	82.00	
"	11	3000	52	112	190	15	78	317	22	110	322	410.00	820	34.58	427.0	29.87	36.46	67.00	
"	13	3000	54	2,000	218	1	111	340	100	140	322	369.90	820	34.58	427.0	29.87	5.03	82.00	
"	22	3000	50	2,100	340	2	111	340	100	140	322	369.90	820	34.58	427.0	29.87	36.46	67.00	
Kathiraveli	17	92	17	1,700	172	3	120	270	440	39	258	300.00	392	5.28	268.0	18.93	80.00	240.00	
"	74	3270	37	2,700	172	13	170	172	440	39	258	300.00	392	5.28	268.0	18.93	83.00	240.00	
"	60	21 3200	12	60	11,200	1	200	440	1700	720	440	1700	720	39.38	372.7	39.38	96.00	240.00	
"	7	27 4000	12	60	11,200	1	200	440	1700	720	440	1700	720	39.38	372.7	39.38	48.62	96.00	
"	7	27 4120	10	70	10,200	2	170	210	2300	320	222	1000.00	700	63.40	226.9	35.19	100.00	240.00	
"	20	27 4000	10	70	10,200	2	170	210	2300	320	222	1000.00	700	63.40	226.9	35.19	5.30	82.00	
"	20	27 4000	10	70	10,200	2	170	210	2300	320	222	1000.00	700	63.40	226.9	35.19	5.30	82.00	
"	20	27 4000	10	70	10,200	2	170	210	2300	320	222	1000.00	700	63.40	226.9	35.19	5.30	82.00	
"	20	27 4000	10	70	10,200	2	170	210	2300	320	222	1000.00	700	63.40	226.9	35.19	5.30	82.00	
"	20	27 4000	10	70	10,200	2	170	210	2300	320	222	1000.00	700	63.40	226.9	35.19	5.30	82.00	
"	20	27 4000	10	70	10,200	2	170	210	2300	320	222	1000.00	700	63.40	226.9	35.19	5.30	82.00	
"	20	27 4000	10	70	10,200	2	170	210	2300	320	222	1000.00	700	63.40	226.9	35.19	5.30	82.00	
"	20	27 4000	10	70	10,200	2	170	210	2300	320	222	1000.00	700	63.40	226.9	35.19	5.30	82.00	
"	20	27 4000	10	70	10,200	2	170	210	2300	320	222	1000.00	700	63.40	226.9	35.19	5.30	82.00	
"	20	27 4000	10	70	10,200	2	170	210	2300	320	222	1000.00	700	63.40	226.9	35.19	5.30	82.00	
"	20	27 4000	10	70	10,200	2	170	210	2300	320	222	1000.00	700	63.40	226.9	35.19	5.30	82.00	
"	20	27 4000	10	70	10,200	2	170	210	2300	320	222	1000.00	700	63.40	226.9	35.19	5.30	82.00	
"	20	27 4000	10	70	10,200	2	170	210	2300	320	222	1000.00	700	63.40	226.9	35.19	5.30	82.00	
"	20	27 4000	10	70	10,200	2	170	210	2300	320	222	1000.00	700	63.40	226.9	35.19	5.30	82.00	
"	20	27 4000	10	70	10,200	2	170	210	2300	320	222	1000.00	700	63.40	226.9	35.19	5.30	82.00	
"	20	27 4000	10	70	10,200	2	170	210	2300	320	222	1000.00	700	63.40	226.9	35.19	5.30	82.00	
"	20	27 4000	10	70	10,200	2	170	210	2300	320	222	1000.00	700	63.40	226.9	35.19	5.30	82.00	
"	20	27 4000	10	70	10,200	2	170	210	2300	320	222	1000.00	700	63.40	226.9	35.19	5.30	82.00	
"	20	27 4000	10	70	10,200	2	170	210	2300	320	222	1000.00	700	63.40	226.9	35.19	5.30	82.00	
"	20	27 4000	10	70	10,200	2	170	210	2300	320	222	1000.00	700	63.40	226.9	35.19	5.30	82.00	
"	20	27 4000	10	70	10,200	2	170	210	2300	320	222	1000.00	700	63.40	226.9	35.19	5.30	82.00	
"	20	27 4000	10	70	10,200	2	170	210	2300	320	222	1000.00	700	63.40	226.9	35.19	5.30	82.00	
"	20	27 4000	10	70	10,200	2	170	210	2300	320	222	1000.00	700	63.40	226.9	35.19	5.30	82.00	
"	20	27 4000	10	70	10,200	2	170	210	2300	320	222	1000.00	700	63.40	226.9	35.19	5.30	82.00	
"	20	27 4000	10	70	10,200	2	170	210	2300	320	222	1000.00	700	63.40	226.9	35.19	5.30	82.00	
"	20	27 4000	10	70	10,200	2	170	210	2300	320	222	1000.00	700	63.40	226.9	35.19	5.30	82.00	
"	20	27 4000	10	70	10,200	2	170	210	2300	320	222	1000.00	700	63.40	226.9	35.19	5.30	82.00	
"	20	27 4000	10	70	10,200	2	170	210	2300	320	222	1000.00	700	63.40	226.9	35.19	5.30	82.00	
"	20	27 4000	10	70	10,200	2	170	210	2300	320	222	1000.00	700	63.40	226.9	35.19	5.30	82.00	
"	20	27 4000	10	70	10,200	2	170	210	2300	320	222	1000.00	700	63.40	226.9	35.19	5.30	82.00	
"	20	27 4000	10	70	10,200	2	170	210	2300	320	222	1000.00	700	63.40	226.9	35.19	5.30	82.00	
"	20	27 4000	10	70	10,200	2	170	210	2300	320	222	1000.00	700	63.40	226.9	35.19	5.30	82.00	
"	20	27 4000	10	70	10,200	2	170	210	2300	320	222	1000.00	700	63.40	226.9	35.19	5.30	82.00	
"	20	27 4000	10	70	10,200	2	170	210	2300	320	222	1000.00	700	63.40	226.9	35.19	5.30	82.00	
"	20	27 4000	10	70	10,200	2	170	210	2300	320	222	1000.00	700	63.40	226.9	35.19	5.30	82.00	
"	20	27 4000	10	70	10,200	2	170	210	2300	320	222	1000.00	700	63.40	226.9	35.19	5.30	82.00	
"	20	27 4000	10	70	10,200	2	170	210	2300	320	222	1000.00	700	63.40	226.9	35.19	5.30	82.00	
"	20	27 4000	10	70	10,200	2	170	210	2300	320	222	1000.00	700	63.40	226.9	35.19	5.30	82.00	
"	20	27 4000	10	70	10,200	2	170	210	2300	320	222	1000.00	700	63.40	226.9	35.19	5.30	82.00	
"	20	27 4000	10	70	10,200	2	170	210	2300	320	222	1000.00	700	63.40	226.9	35.19	5.30	82.00	
"	20	27 4000	10	70	10,200	2	170	210	2300	320	222	1000.00	700	63.40	226.9	35.19	5.30	82.00	
"	20	27 4000	10	70	10,200	2	170	210	2300	320	222	1000.00	700	63.40	226.9	35.19	5.30	82.00	
"	20	27 4000	10	70	10,200	2	170	210	2300	320	222	1000.00	700	63.40	226.9	35.19	5.30	82.00	
"	20	27 4000	10	70	10,200	2	170	210	2300	320	222	1000.00	700	63.40	226.9	35.19	5.30	82.00	
"	20	27 4000	10	70	10,200	2	170	210	2300	320	222	1000.00	700	63.40	226.9	35.19	5.30	82.00	
"	20	27 4000	10	70	10,200	2	170	210	2300	320	222	1000.00	700	63.40	226.9	35.19	5.30	82.00	
"	20	27 4000	10	70	10,200	2	170	210	2300	320	222	1000.00	700	63.40	226.9	35.19	5.30	82.00	
"	20	27 4000	10	70	10,200	2	170	210	2300	320	222	1000.00	700	63.40	226.9	35.19	5.30	82.00	
"	20	27 4000	10	70	10,200	2	170	210	2300	320	222	1000.00	700	63.40	226.9	35.19	5.30	82.00	
"	20	27 4000	10	70	10,200	2	170	210	2300	320	222	1000.00	700	63.40	226.9	35.19	5.30	82.00	
"	20	27 4000	10	70	10,200	2	170	210	2300	320	222	1000.00	700	63.40	226.9	35.19	5.30	82.00	
"	20	27 4000	10	70	10,200	2	170	210	2300	320	222	1000.00	700	63.40	226.9	35.19	5.30	82.00	
"	20	27 4000	10	70	10,200	2	170	210	2300	320	222	1000.00	700	63.40	226.9	35.19	5.30	82.00	
"	20	27 4000	10	70	10,200	2	170	210	2300	320	222	1000.00	700	63.40	226.9	35.19	5.30	82.00	
"	20	27 4000	10	70	10,200	2	170	210	2300	320	222	1000.00	700	63.40	226.9	35.19	5.30	82.00	
"	20	27 4000	10	70	10,200	2	170	210	2300	320	222	1000.00	700	63.40	226.9	35.19	5.30	82.00	
"	20	27 4000	10	70	10,200	2	170	210	2300	320	22								

Topographic Sheet																					Topographic Sheet	
Trincomalee	140.00	1.21	1195.00	49.92	305.0	3.45	2000.00	617	400	820	340	12	200	100	200	520	9,200	90	90	12	3100	
Vavuniya	420	8.50	580.00	145.48	616.8	14.40	1200.00	2100	900	480	31	2	1	1	22	70	720	17	427	47	1000	
"	425	220	955.06	35.97	483.2	4.80	1700.00	2100	720	400	48	7	78	11	17	43	1,300	11	322	37	750	
"	426	226.00	82.00	39.10	471.6	4.80	420.00	1210	800	400	27	3	2	1	27	22	610	30		181	200	
Mantai	427	222.00	966.00	82.51	610.1	14.45	1720.00	1700	870	320	22	2	7	2	17	24	220	22		27	1000	
"	429	208.00	992.00	43.41	556.4	4.89	1720.00	1700	720	460	22	13	42	1	110	300	12,000	28	278	92	1800	
Nilaveli	431	200.00	511.00	67.26	427.6	53.31	1200.00	1300	900	640	21	14	17	3	110	1700	11,000	27	231	90	1000	
"	432	300.00	1678.00	23.85	1043.9	14.88	2700.00	1250	1000	820	20	17	22	2	220	420	9,000	11	431	11	800	
Padawiya	436	216.03	97.25	1057.00	34.41	1037.2	34.58	1700.00	1500	940	3800	24	12	27	12	220	21	3,200	12	122	71	1500
"	437	204.00	109.00	678.16	19.55	738.0	35.00	1270.00	1700	960	3800	72	2	1	1	17	20	100	17	327	43	1400
"	438	220.00	85.00	781.60	1.95	921.0	44.00	1270.00	2000	900	400	23	3	11	1	270	27	2,100	22	131	27	2000
"	443	160.00	3.79	643.67	8.21	488.0	15.00	1000.00	953	416	220	20	10	12	nd	24	19,000	37	17	21	100	
Galgamuwa	445	87.00	24.31	206.89	10.16	372.0	20.00	320.00	1300	320	400	190	14	12	11	60	21	5,600	47	23	22	1000
"	446	94.42	36.46	114.94	28.15	439.0	24.00	203.00	1919	386												
"	448	40.08	11.67	160.91	23.85	128.0	15.36	290.00	1480	398	720	270	19	2	2	61	22	9,200	87	41	2	500
"	449	40.08	3.89	206.89	35.19	183.0	44.18	294.90	452	202	560		21	8	17	63	71	7,200	92	117	3	1000
"	450	12.82	36.46	183.90	28.00	243.0	5.28		1012	423	2000	430	17	11				97	122	21	600	
"	459	67.94	36.47	321.83	150.00	427.0	15.36	620.00	420	320	420	120	7	2	27	17	17,000	8	82	27	1500	
Kala Oya	470	110.00	12.16	321.83	179.00	122.0	206.00	700.00	444	327	320	170	3	1	211	21	22	2,700	11	32	31	1200
"	471	88.00	12.16	344.82	195.00	427.0	48.00	622.00	443	372	110	120	2	3	2	20	18	3,000	17	37	30	1100
"	476	51.30	12.16	206.89	191.00	61.0	154.00	470.00	342	178	610	142	9	18	273	18	70	2,100	2	87	40	1000
"	472	72.00	19.94	275.86	82.00	220.0	63.00	490.00	453	332	810	75	7	27	24	32	10	1,900	9	43	21	1100
"	475	92.06	12.16	505.74	243.00	274.0	53.00	1000.00		280	110	72	2	7	12	42	22	2,100	17	32	32	400
"	479	75.23	24.31	344.82	150.00	195.0	53.00	20.00		288	1000	78	12	11	2	36	72	3,100	10	14	14	330
"	481																					
"	482																					
 																						

Chemical Results of the Sampled Well Water Na + K/SO₄ Subgroup

Loca- tion No.	Ca	Mg	Na	K	HCO ₃	SO ₄	Cl	TDS	Total Hard- ness	Total Fe	Mn	Total Cr	Total Co	Total V	Cu	Zn	NO ₃	NO ₂	NH ₄	SiO ₂	F
	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm in CaCO ₃	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppm	ppb
25	0.21	0.01	25.5	0.04	6.7	35.1	10	432	401	2000	77	7	4	12	3	21	810	71	47	28	500
																					Ambalantota

Chemical Results of the Samples Well Water Na + K/HCO₃ Subgroup

Loca- tion No.	Ca	Mg	Na	K	HCO ₃	SO ₄	Cl	TDS	Total Hard- ness	Total Fe	Mn	Total Cr	Total Co	Total V	Cu	Zn	NO ₃	NO ₂	NH ₄	SiO ₂	F
	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm in CaCO ₃	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppm	ppb
40	6.80	4.00	2.29	18.48	43.9	5.28	10	42	27	720	43	20	27	7	30	7	1,300	80	12	3	100
68	20.4	0.22	68.96	17.83	60.4	4.80	120	384	53	250	82	21	1	10	12	34	9,700	182	10	11	170
																					Rakwana Pandura

Chemical Results of the Sampled Well Water Na + K/NDA Subgroup

Loca- tion No.	Ca	Mg	Na	K	HCO ₃	SO ₄	Cl	TDS	Total Hard- ness	Total Fe	Mn	Total Cr	Total Co	Total V	Cu	Zn	NO ₃	NO ₂	NH ₄	SiO ₂	F
	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm in CaCO ₃	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppm	ppb
44	80.00	11.02	91.95	38.32	183.0	96.06	161.00	340	328	1100	57	2	12	72	24	143	7,100	17	40	27	720
49	40.00	11.16	68.96	20.98	80.5	82.61	108.00	132	128	110	78	10	1	142	132	27	2,000	90	10	25	610
99	7.20	0.24	13.44	7.82	40.8	0.52	20.00	72	280	6220	112	30	17	222	2	712	11,000	45	70	1	500
105	8.80	0.48	45.97	1.51	56.1	0.52	42.00	112	61	4490	70	22	7	2	12	270	1,000	17	12	10	330
115	20.04	0.22	22.98	4.81	57.3	4.41	10.00	112	51	910	30	2	1	1	80	80	10,000	137	11	7	30
156	0.20	0.48	4.36	0.18	6.1	3.36	3.00	200	210	3100	90	7	111	17	67	18	3,520	210	1000	12	100
253	156.00	12.15	206.89	29.33	473.2	82.61	320.00	420	440	440	100	7	1	30	141	21	10,300	317	770	122	400
281	100.00	2.36	114.94	24.24	305.0	63.46	158.00	340	360	110	82	21	7	1	47	210	6,000	17	617	27	70
304	87.00	48.62	183.90	17.20	433.8	101.44	270.00	420	420	210	120	3	22	17	111	42	100	17	87	2	1370
																					Katharagana Colombo Avisawella Hatten Kandy Kalmune Nalanda Rukun

Chemical Results of the Sampled Well Water NDC - Cl Subgroup

Location No.	Ca	Mg	Na	K	LiCO ₃	SO ₄	Cl	TDS	Total Hardness ppm in CaCO ₃	Total Fe	Mn	Total Cr	Co	Total V	Cu	Zn	NO ₃	NO ₂	NH ₄	SiO ₂	F	Topographic Sheet
2	42.00	10.97	39.60	39.90	61.9	1.30	170.00	320	4200	2790	100	22	22	72	11	13	9,200	18	90	37	100	Ambalangoda
19	60.10	6.52	48.50	42.60	128.8	54.30	130.00	1000	1770	73	73	12	2	20	2	22	110	62	89	3	780	Ambalangoda
21	80.00	36.40	48.50	0.39	61.7	37.50	280.00	470	300	2700	140	2	17	40	7	27	20	69	75	17	2000	"
22	46.40	36.47	71.50	47.32	105.0	62.70	256.00	320	216	1180	122	4	22	11	7	12	10	120	27	43	1230	"
54	60.10	60.12	91.90	30.05	199.0	3.40	266.00	320	304	210	75	7	1	157	20	73	100	11	11	32	600	Katragama
57	60.10	12.03	68.90	20.10	122.0	5.76	190.00	502	75	500	124	3	12	217	72	35	1,000	120	7	27	520	Yala
77	2.60	1.33	2.82	2.73	0.6	0.96	10.00	43	12	920	92	10	1	2	17	217	2,000	27	20	3	200	Haputale
87	4.30	2.43	7.38	0.18	7.0	3.36	20.00	92	20	700	48	17	1	17	6	372	120	111	11	15	700	"
93	28.00	1.21	7.38	3.91	10.3	0.52	90.00	340	120	700	60	12	11	7	10	412	6,000	400	10	17	2370	Burtala
97	40.00	0.24	45.97	1.85	59.7	3.45	92.00	1200	110	120	72	12	3	7	21	318	6,000	127	7	12	980	"
103	8.80	0.48	7.22	11.73	43.3	0.04	26.00	114	42	2210	70	30	2	17	1	230	4,000	12	82	2	230	Avisawella
135	10.00	36.46	121.00	39.10	348.9	4.41	270.00	1900	400	310	85	12	110	21	117	13	100	120	74	41	230	Potuvil
139	60.10	4.83	45.00	85.32	122.0	4.80	117.00	200	170	6220	100	11	17	2	9	17	10,000	27	11	12	110	Negombo
149	40.00	4.83	45.00	0.18	56.1	6.34	92.00	211	120	3000	12	24	2	2	7	27	2,000	72	13	3	500	Gampaha
219	20.00	10.64	2.29	19.59	60.4	3.39	50.00	211	94	720	72	10	3	11	52	27	4,000	127	33	11	200	Kurunegala
227	20.00	5.57	2.29	18.38	7.3	5.76	40.00	170	73	710	43	7	1	31	60	73	10,000	22	14	2	110	"
255	147.00	36.46	229.00	26.20	450.2	101.34	410.00	420	520	110	120	7	8	31	120	17	10,000	132	300	17	310	Kalmunc
278	80.00	16.95	68.00	36.60	195.8	63.40	170.00	270	270	110	75	12	7	8	40	170	6,000	24	612	17	170	Nalanda
305	95.00	12.15	114.00	2.73	263.5	53.36	200.00	440	300	170	112	7	17	111	122	121	820	2	27	13	2000	Rukam
318	98.30	12.15	114.00	18.38	263.5	53.31	211.00	294	296	560	220	12	1	17	31	24	1,700	21	327	2	400	Puttalam
319	100.00	4.80	91.00	38.71	196.4	19.21	340.00	616	270	480	430	7	17	2	23	10	7,200	70	47	11	720	Dambulla
321	87.00	24.31	137.00	22.68	250.7	44.18	280.00	800	318	320	270	8	27	17	37	27	6,200	62	37	4	320	"
328	120.00	10.61	137.00	33.63	366.0	5.28	270.00	700	344	110	58	12	30	42	72	500	100	42	12	7	13130	Polonnaruwa
379	80.00	55.31	206.00	19.94	313.1	10.08	270.00	388	428	210	20	12	3	3	64	415	110	27	98	10	3000	Kaudulla
380	84.00	53.00	137.00	0.89	330.0	34.58	300.00	470	429	110	21	10	2	7	120	317	110	12	92	11	3200	"
409	107.60	6.10	165.00	27.76	355.0	5.81	400.00	1700	520	270	22	2	113	13	75	40	420	97	27	31	1000	Horowapana
410	120.00	8.74	0.22	39.10	434.4	3.45	170.00	1500	600	170	2	3	42	71	120	22	600	92	32	37	970	"
413	204.00	2.43	183.00	67.26	433.8	5.31	500.00	2150	610	410	22	22	32	37	198	22	2,700	86	113	17	1000	"
414	220.00	12.15	114.00	105.00	682.7	5.81	500.00	2100	1200	230	24	17	42	37	240	27	7,000	82	17	32	1200	"
415	188.00	6.07	91.00	38.15	470.4	3.45	400.00	2150	720	130	27	10	32	43	220	13	9,000	82	32	37	1000	"
422	260.00	8.50	224.00	58.71	610.1	4.75	700.00	2010	1000	400	22	1	8	3	17	27	4,000	17	322	47	800	Vavuniya
433	312.00	48.62	275.00	14.47	629.6	63.40	720.00	2000	980	800	45	1	7	17	15	41	800	17	170	47	500	Puliyankulam
484	71.00	24.31	68.00	27.76	189.7	67.72	179.00	295	295	1120	75	7	1	1	27	27	2,000	17	117	27	3101	Kala Oya

Chemical Results of the Sampled Well Water NDC—SO₄ Subgroup

Loca- tion No.	Ca ppm	Mg ppm	Na ppm	K ppm	HCO ₃ ppm	SO ₄ ppm	Cl ppm	TDS ppm	Total Hard- ness ppm in CaCO ₃	Total Fe ppb	Mn ppb	Total Cr ppb	Co ppb	Total V ppb	Cu ppb	Zn ppb	NO ₃ ppb	NO ₂ ppb	NH ₄ ppb	SiO ₂ ppm	F ppb	Other Remarks
6	80.16	18.00	68.90	39.10	105.0	289.40	120.00	372	378	3100	110	22	12	23	11	21	100	120	81	17	100	Ambalangoda
17	80.16	53.87	48.50	4.30	128.8	297.40	97.00	453	422	2700	68	10	3	36	13	23	5000	10	82	68	210	Morawaka
18	86.81	48.63	30.40	8.21	128.8	339.00	25.00	437	417	3700	41	24	2	10	11	24	5210	21	80	63	10	Morawaka
24	84.81	48.63	25.50	0.39	122.0	272.20	60.00	428	412	2000	72	10	3	10	7	27	210	70	17	2	1920	Ambalangoda
42	6.01	1.98	2.29	5.02	6.7	15.36	7.00	43	20	1960	42	19	11	7	10	2	2300	120	1	2	400	Rakwana
118	20.04	6.44	17.93	3.91	26.2	92.69		114	77	1010	30	3	22	1	59	80	1700	420	21	12	70	Hatton
464	55.91	97.25	26.66	156.43	305.0	470.22	40.76	200	540			12	3				900		17	1	nd	Timbolketiya
474	86.57	24.31	91.95	36.74	245.2	293.51	37.00	448	312	720	122	17	22	22	21	17	2700	3	67	24	1100	Kala Oya

Chemical Results of the Sampled Well Water NDC - HCO₃ Subgroup

Loca- tion No.	Ca	Mg	Na	K	HCO ₃	SO ₄	Cl	TDS	Total Hard- ness	Total Fe	Mn	Total Cr	Co	Total V	Cu	Zn	NO ₃	NO ₂	NH ₄	SiO ₂	F	Topographic Sheet	
72	20.04	14.95	11.58	3.91	104.3	34.58	17.00	200	112	2920	120	2	2	7	49	22	2,100	62	20	3	380	Ratnapura	
73	32.00	12.52	28.25	0.86	117.1	68.20	12.00	260	132	1980	143	3	3	1	49	17	110	51	7	2	320	"	
74	26.00	12.52	22.10	3.91	122.0	34.50	18.00	270	117	2000	92	7	3	1	47	70	8,000	53	7	7	410	"	
75	30.00	12.15	23.92	3.61	117.1	48.00	20.00	220	127	720	93	11	2	3	52	72	7,920	17	7	1	390	"	
83	6.79	3.64	1.97	0.68	22.5	14.40	2.00	42	27	270	42	12	4	3	10	412	1,700	21	7	3	520	Haputale	
107	8.00	0.36	9.45	3.91	44.5	0.81	10.99	79	35	6860	72	24	3	27	11	121	11,000	27	17	3	420	Avissewella	
127	9.19	6.07	1.37	4.28	43.3	0.38	11.99	120	48	720	22	17	22	7	21	213	10,000	217	2	11	100	Nuwara Eliya	
133	68.00	36.00	68.90	3.48	305.0	5.81	116.01	1750	320	110	82	7		17	12	14	210	143	50	71	270	Potuvil	
164	60.00	6.76	19.99	0.39	176.9	48.00	19.00	170	178	2310	82	2	17	21	43	17	8,310	28	327	12	150	Kandy	
167	60.00	5.30	13.79	3.01	190.0	20.60	20.00	120	172	1220	22	13	41	11	41	21	7,000	77	312	7	10	"	
181	68.00	36.00	45.90	9.64	324.5	63.40	69.99	210	320	120	41	10	13	13	73	72	2,100	140	773	2	20	Nilgala	
185	67.90	36.30	22.90	4.93	312.3	7.45	2.79	145	320	110	41	3	1	1	73	72	110	28	773	17	2900	Tirrukkovil	
190	76.00	36.30	22.90	14.08	366.0	3.18	47.00	527	340	430	114	7	2	1	150	53	1,000	412	1400	27	2300	"	
191	96.40	48.40	11.40	19.55	483.2	3.84	31.99	500	441	520	117	13	3	3	32	160	77	10	317	1700	22	2100	"
193	88.00	48.40	43.90	13.69	450.8	7.76	48.00	470	420	110	100	11	8	39	140	12	100	317	4000	18	2300	"	
217	20.00	11.40	0.22	1.01	61.0	5.76	30.00	213	97	900	72	12	1	32	73	172	21,400	311	37	11	320	Kuruncgala	
241	120.00	72.00	91.90	4.10	609.5	130.60	120.00	500	600	780	100	10	14	120	70	110	880	227	722	21	20	Maha Oya	
245	88.00	48.00	22.90	26.20	233.8	44.10	71.99	170	420	120	110	7	1	42	73	211	280	622	622	1	70	"	
263	67.10	48.00	45.90	2.73	427.0	10.00	80.00	777	368	730	122	18	11	13	31	12	12,800	278	22	27	410	Wariyapola	
265	61.60	36.00	22.90	9.15	309.3	53.30	40.00	400	304	720	100	18	2	7	28	22	7,200	420	18	42	410	"	
266	44.80	24.00	2.29	7.12	244.0	11.30	10.00	417	212	110	110	15	21	2	31	30	3,000	417	18	1	400	"	
267	68.00	36.00	2.29	17.75	366.0	18.70	20.00	400	320	120	73	18	10	7	33	210	3,200	22	718	22	170	Nalanda	
277	68.00	36.00	2.29	17.75	366.0	18.70	20.00	400	320	120	73	18	10	7	33	210	3,200	22	718	22	170	Nalanda	
279	72.00	24.00	22.90	24.63	244.0	101.40	40.00	300	280	310	77	13	2	1	41	170	6,000	25	514	3	270	"	
286	43.60	12.15	22.00	5.47	193.4	34.60	16.00	540	159	810	100	18	22	12	42	170	4,600	100	332	1	270	Elahera	
294	48.00	12.51	22.00	23.86	189.7	68.20	17.00	370	170	610	77	18	17	2	65	317	10,000	114	471	5	230	"	
299	60.10	46.30	22.00	18.65	354.6	101.40	12.98	341	341	110	140	12	3	8	61	320	4,300	50	112	2	100	"	
300	63.70	36.40	2.29	5.86	330.6	63.40	10.99	342	342	430	122	12	2	1	80	420	5,000	62	172	3	18	7000	"
302	97.60	48.60	2.29	30.93	477.1	63.40	21.99	4444	444	120	75	17	1	1	69	321	6,000	17	172	11	320	"	
435	300.00	60.00	1678.00	23.85	1043.9	14.80	2700.00	2100	970	320	40	4	2	2	20	31	720	28	100	31	1000	Puliyankulam	

[illegible]

[illegible]

Chemical Results of the Samped Well Water (Un Classified data)

Location Number	TDS ppm	Total Hardness ppm in CaCO ₃	Total Cr ppb	Cl ppm	Fe ppb	Mn ppb	Zn ppb	Co ppb	NO ₃ ppb	NO ₂ ppb	NH ₄ ppb	SiO ₂ ppm	Cu ppb	Total V ppb	F ppb	Topographic Sheet
13	330	317	21	135	2320	42	17	27	7,100	62	27	17	42	28	60	Morawaka
14	320	312	17	350	3000	72	18	2	10,000	28	30	62	12	20	100	"
20	1100	4170	3	465	1780	71	27	7	110	57	92	27	5	30	1000	Anbalantota
71		113	1	10	2000	98	18	11	8,000	27	62	9	43	2	170	Ratnapura
81	30	10	3	14	10	45	312	3	820	22	11	2	10	3	820	Haputale
96	1200	270	14	89	720	62	217	1	820		11	12	17	8	2070	Buttala
112	82	40	10	3	1110	40	77	7	3,700	127	62	17	51	3		Hatton
189	540	370	7	37	730	122	71	11	710	317	1270	47	160	72	2700	Turukkovil
215	117	211	6	80	1720	66	120	3	5,400	411	27	1	53	21	130	Kurunegala
228	173	97	2	20	110	34	120	1	8,000	17	27	8		3	100	"
235	200	44	17	10	720	42	318	2	4,000	27	522	12	14	117	130	Rangala
247	272	440	10	17	170	122	112	12	10	627	627	7	87	67	110	Maha Oya
249	270	240	17	17	600	120	170	2	11,700	322	322	5	67	320	920	"
254	700	540	1	327	620	80	132	7	10,200	127	270	2	140	32	410	Kalmunai
274	720	340	21	190	110	72	12	117	5,600	17	712	11	34	27	140	Nalanda
311	420	422	2		500	120	313	11	32		22	3	91	338	3200	Rukam
315	1512	712		188	400	160	17	1	1,100	12	4200		41	7	400	Puttalam
320	700	217	7	680	640	300	77	22	2,400	75	28	3	21	7	130	Dambulla
329	720	356	20	320	10	38	34	11	31	17	3	72	72	17	720	Polonnaruwa
331	670	342	12	117	120	82	522	13	610	37	27	7	70	47	10020	Polonnaruwa
336	811	268	8	1400	3400	270	210	127	200	32	114	112	162	113	2000	Vakanceri
384		361	8	100	4300	440	422	21	nd	17	73	21	198	2	3300	Kathiraweli
397															4000	Anuradhapura
398															3100	Kala Oya
399															4500	"
406	1000	620	2	72	20	nd	12	21	2,110	91	27	27	27	43	500	Horowapata
434	2130	700	3	1720	560	40	42	1	820	22	100	27	10	3	750	Puliyankulam