Water in South Asia
Volume 3

Interlacing Water and Human Health

Case Studies from South Asia

Editors
Anjal Prakash
Saravanan V.S.
Jayati Chourey

SaciWATERs

SAGE www.sagepublications.com
Los Angeles • London • New Delhi • Singapore • Washington DC

First published in 2011 by

SAGE Publications India Pvt Ltd
B 1/I-1, Mohan Cooperative Industrial Area
Mathura Road, New Delhi 110044, India
www.sagepub.in

SAGE Publications Inc
2455 Teller Road
Thousand Oaks, California 91320, USA

SAGE Publications Ltd
1 Oliver's Yard, 55 City Road
London EC1Y 1SP, United Kingdom

SAGE Publications Asia-Pacific Pte Ltd
33 Pekin Street
#02-01 Far East Square
Singapore 048763

Published by Vivek Mehra for SAGE Publications India Pvt Ltd, typeset in 11/13pt Adobe Garamond by Star Compugraphics Private Limited, Delhi and printed at Chaman Enterprises, New Delhi.

Library of Congress Cataloging-in-Publication Data

ISBN: 978-81-321-0725-5 (HB)

The SAGE Team: Elina Majumdar, P.K. Jayanthan,

15

Wastewater in Sri Lanka

Implications on Human Health

MOHAMED MUJITHABA MOHAMED NAJIM
AND INDIKA HARSHANI RAJAPAKSHE

INTRODUCTION

TRADITIONALLY IN SRI LANKAN villages domestic wastewater, especially grey-water generated from kitchens and bathrooms of a household, flows along open unlined wastewater drains and is collected in a garden pool known as *kohila wala* or vegetation pool. This pool is a kind of traditionally constructed wetland. Main vegetation type cultivated in the wetland is kohila (*Lasia spinosa*) which is used as a leafy and stem vegetable. Medicinal and other important plants are also grown along the drains that utilise the wastewater and its nutrients. This system of grey-water disposal and utilisation was always kept separate from the black-water disposal system as the latter is disposed to individual cesspits located in home gardens. In the traditional system, natural capacity to treat wastewater without any harmful effects to groundwater was possible due to low population density and land availability. With the population expansion in urban centres, the land value increased and land area available for the traditional wastewater treatment process shrank.

Sri Lanka has experienced a rapid growth of population in some areas, putting pressure on its land and water resources. Sri Lankan population in 2001 was 18.8 million and it was estimated at 19.37 million in 2005 (ADB 2006). Sri Lankan population can be classified mainly into three categories; urban (including peri-urban), rural and estate (mainly labour force employed in the tea and rubber estates). Sector-wise population variation, according to the Census of

Population and Housing in 2001, shows 14.6 per cent, 80.0 per cent and 5.4 per cent respectively in urban, rural and estate areas respectively (DCS 2001). Out of the urban population in 2001, 14 per cent live in slums (World Bank 2005) and the slum population in greater Colombo area is 43 per cent (ADB 2006).The urban population in 2005 increased to 21 per cent (World Bank 2005) or 4.07 million. The estimated average growth of capital cities or urban agglomerations during 2005 to 2015 is 13 per cent. Increase in population has created many issues related to wastewater disposal such as deterioration of water quality and health.

Urbanisation is the driving force for modernisation, economic growth and development. Water supply and waste disposal systems are unable to keep pace with development under resource-poor environments, leading to disposal of wastewater including grey-water from kitchens and/or bathrooms and black-water from toilets. The World Health Organisation (WHO) in its World Health Report of 2002 (WHO 2002) stated that unsafe water, sanitation and hygiene were one of the most important risk factors among developing countries. Most Southeast Asian countries fall into this group.

Urbanisation limited the land needed for traditional wastewater disposal mechanism that was being practised in the country. The grey-water generated is disposed mostly into a drain that is used primarily as a storm water drain, an irrigation canal or a natural water way, such as a rivulet or a streamlet. Black-water and other toilet wastes have contaminated natural, surface and groundwater sources such as streams, wells, springs, and so on due to poor sanitation, including inappropriate faecal matter disposal, inappropriate toilets and toilet pits and their improper installation and maintenance. On the other hand, Sri Lanka is blessed with high rainfall and perennial watercourses and it is unavoidable that cities are built close to water sources. This has resulted in intensification of the water pollution problem.

Water pollution due to domestic and municipal discharges has affected potable sources of water posing serious health hazards. In Sri Lanka, diseases resulting from poor sanitation and hygiene rank among the leading causes of hospitalisation and ill health (Shanmugarajah 2002). Poorly managed wastewater in urban and peri-urban areas has created lots of health problems for the downstream community as well as the city dwellers.

This chapter is based on two case studies, one from Kurunegala district and the other from Pussella Oya catchment. One of the major health concerns in Kurunegala city itself is the high incidence of filariasis (Rajapakshe et al. 2007). On the other hand, Pussella Oya catchment is the source area for Hepatitis A and an outbreak was recorded in Gampola in May 2007. In fact, faecal pollution has contaminated water sources in Pussella Oya and many other catchments. Besides, expanding cities have increased the concern on effects, principally on human health, livelihoods and the environment. This problem is no longer simply an issue for environmentalists to deal with but requires other experts' attention.

Problems of Wastewater Generation in Sri Lanka

The average water consumption in Sri Lanka is 120 l/capita/day, according to National Water Supply and Drainage Board (NWSDB). Wastewater return flow from water consumption is 70 per cent, which is an internationally accepted figure for wastewater generation. Estimated annual wastewater generation in the country is about 400 million cubic metres. Out of this, 25 per cent is considered as black-water and the remaining as grey-water. The wastewater generation can vary in volume according to geographical location, climate, people's behaviour, level of industrialisation, urban population served with piped water, and so on. Most of the grey-water and a part of the black-water generated, are diverted to the sea or surface water bodies without any treatment.

Generally, urban wastewater generation is 20–40 per cent from the total wastewater generation in Sri Lanka. Urban wastewater is a combination of some or all of domestic effluents consisting of black-water (excreta, urine and associated sludge), yellow-water (only urine), grey-water (kitchen and bathroom wastewater), water from commercial establishments and institutions (hospitals, industries, and so on.), storm-water and other urban runoff (Van der Hoek 2004). Levels of industrialisation are low in most of the cities in Sri Lanka. Therefore, the main risk in all cases appears to be from hospitals, service stations and slaughter houses which discharge untreated or partially treated wastewater. Most hospitals have treatment plants, but they function poorly after an initial period of good operation. Most of the industries in the country have wastewater treatment plants, specially the ones in industrial parks or zones. Untreated or partially treated wastewater is disposed off into drains affecting downstream communities.

Massive volumes of urban wastewater generation weaken the natural wastewater treatment capability and necessitate conventional wastewater treatment. However, centralised conventional wastewater treatment facilities are limited to very few areas in Sri Lanka and the only major city that has a system is Colombo Municipality. Less than 25 per cent of wastewater in the Colombo Municipal Council area is treated through the system (ADB 2006).

Disposal Systems in Sri Lanka

There are many kinds of onsite excreta disposal systems used in latrines, such as cesspits or soakage pits, septic tanks, biofilters, soakage trenches, sewage systems, dry composting pits, and so on. The traditional on-site excreta disposal mechanism in Sri Lanka includes soakage pits and the common excreta disposal mechanism involves use of septic tanks. It is reported that 80 per cent of the urban and suburban population in Sri Lanka use septic tanks for the disposal of faecal waste. The septic tank effluents need further treatment before they are discharged safely. Therefore, septic tank and associated effluent disposal systems need to be designed and implemented properly, in order to prevent failures, public health hazard and environmental pollution.

Sri Lanka Standard Institution (SLSI) has established guidelines (SLS 745–2003) for the design and construction of septic tanks and associated effluent disposal systems. These guidelines propose primary, secondary and tertiary systems to treat the effluents before discarding them safely, depending on the sink and source. The guidelines for primary treatment cover the design, construction, testing and maintenance of septic tanks for the disposal of domestic wastewater including black-water, grey-water and all waste systems. It also recommends guidelines for the selection, design, construction and maintenance of systems for the on-site disposal of effluents from septic tanks as secondary and tertiary treatments. Based on a combination of technical and financial considerations and preferred option of disposal, that is reuse, disposal on ground, drain, and so on, different configurations are proposed for the disposal of septic tank effluent for Sri Lankan conditions (Table 15.1).The proposed effluent disposal combinations are not implemented in most of the cases as there is no methodology for implementation or to monitor the implementation of the proposed standards.

Table 15.1: Proposed Configurations for the Disposal of Septic Tank Effluents for Sri Lankan Conditions

Preferred Option of Disposal	*Alternative Options*
Disposal on ground	Septic Tank (ST) → Soakage Pit → Ground
	ST → Seepage bed → Ground
	ST → Seepage trench → Ground
Disposal into surface drains and/or ground	ST → Biofilter → Surface drain
	ST → Constructed wetland (unlined) → Surface drain and/or Ground
	ST → Constructed wetland (lined) → Surface drain
Disposal jnto surface water and/or re-use	ST → Constructed wetland (lined) → Constructed wetland (lined) → surface water/reuse
	ST→ Constructed wetland (lined) → Percolation bed → Reuse and/or surface water
	ST → Biofilter → Constructed wetland (lined) → Reuse and/or surface water
	ST → Biofilter → Percolation bed → Reuse and/or surface water

Source: SLSI (2003).

Primary selection criteria in an excreta disposal system for a particular site are the type and porosity of the soil. The depth to seasonally fluctuating water table and distance between water wells and septic tanks are also of concern. The minimum required distance (Table 15.2) varies depending on soil type (Werellagama et al. 2003).

According to the SLS 745, the most common single cause of failure of septic tank systems has been the indiscriminate use of soakage pits for the disposal of septic tank effluents into the ground (SLSI 2003). Such failures are mainly attributed to poor attention paid on local soil conditions, groundwater table and urban congestion. Lack of

Table 15.2: Recommended Minimum Distances Between a Dug Well and Source of Faecal Contamination

Contamination Source	*Recommended Distance (m)*
Building sewer	15
Septic tank	15
Disposal field	30
Seepage pit	30
Cess pool	45

Source: Werellagama et al. (2003).

awareness of implementers and regulators of appropriate alternative cost-effective means of effluent disposal has also contributed to the failures.

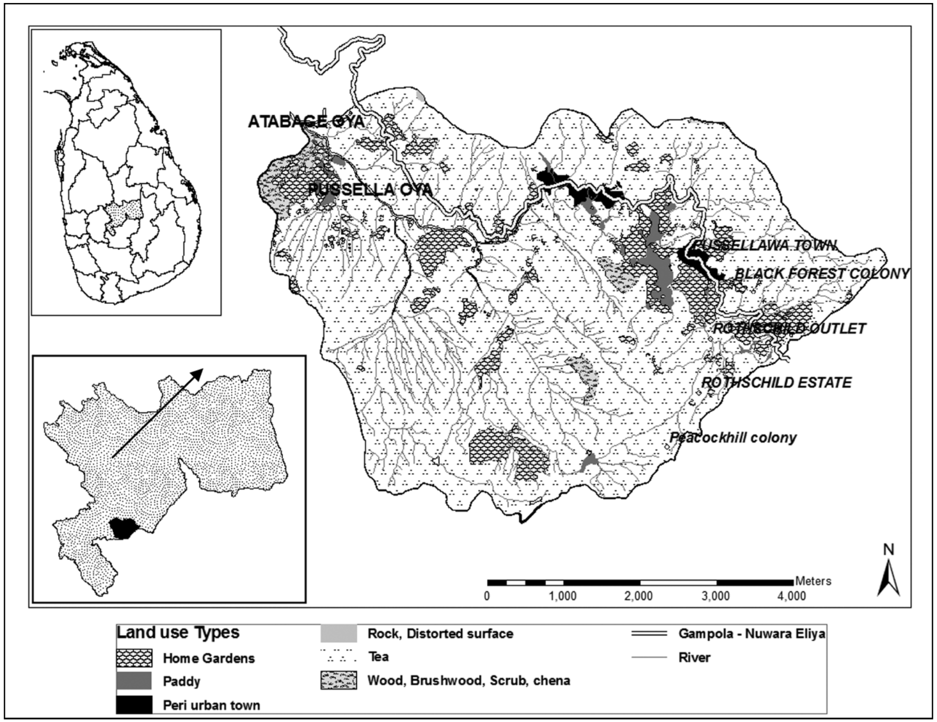
Problems Related with Improper Disposal of Wastewater

Two locations were studied to identify major pollution contributors and the impacts of improper wastewater disposal mechanisms in Sri Lanka. The first case study was conducted in Pussella Oya catchment, reaching all the three communities, estate, rural and urban, living in the catchment. The second case study was conducted in four selected Public Health Inspection (PHI) areas in Kurunegala district (including the city Kurunegala) to identify the variation in water related diseases and reasons for the identified variations.

Case Study 1: Pussella Oya Catchment

One of the reported impacts of poor sanitation in Sri Lanka was the outbreak of Hepatitis A in Gampola in 2007. Pussella Oya catchment (Map 15.1), a small tributary of the Mahaweli River, the largest river in Sri Lanka that covers one-third of the country, was identified by the Ministry of Healthcare and Nutrition as one of the sources responsible for the outbreak of the disease due to water intake available in the stream. Therefore, a case study was conducted in Pussella Oya catchment to identify the wastewater disposal mechanism and its impact on the society. Three different communities were selected

Map 15.1: Pussella Oya Catchment

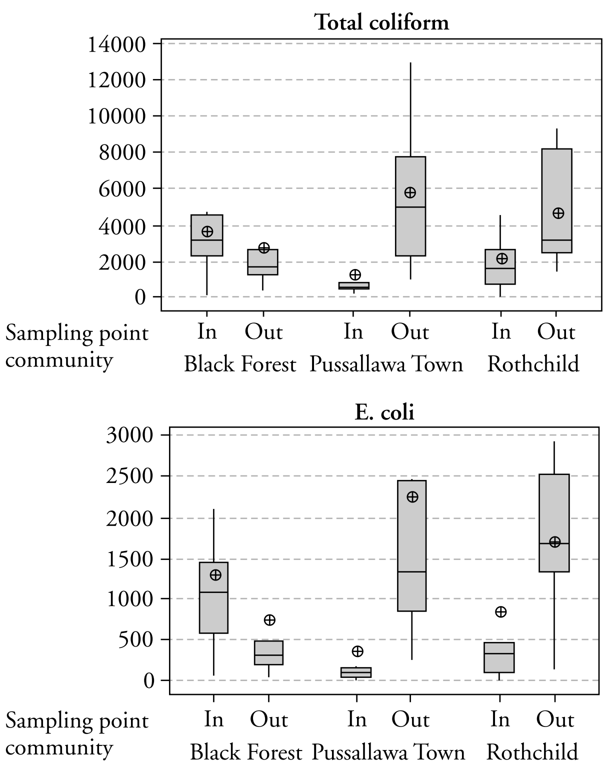


to represent the three main community types as Rothschild Estate, Pussellawa Town and Black Forest Colony which represent the estate (tea plantations), peri-urban town and village (rural) communities, respectively (Map 15.1).

Deterioration of Surface Water

The average surface water quality variation among the three different communities in terms of inflow and outflow water is shown in Figure 15.1. This difference indicates the contribution of the area to pollution. The outflow water quality (Total Coliform–5849 CFU/100ml and E. Coli –2272 CFU/100ml) is significantly poor

Figure 15.1: Surface Water Quality Variation among Different Communities in Terms of Inflow and Outflow Water



when compared with inflow water quality (Total Coliform–1328 CFU/100ml and E. Coli–379 CFU/100ml) in Pussellawa Town and in Rothschild Estate (Inflow water quality: Total Coliform–2233 CFU/100ml and E. Coli–861 CFU/100ml. Outflow water quality: Total Coliform– 4731 CFU/100ml and E. Coli–1728 CFU/100ml). The highest pollution level of the outflow water was found from the Pussellawa Town area followed by the Rothschild Estate.

Pussellawa town is a densely populated peri-urban town community. Land area is limited to construct individual wastewater treatments and there is no common or centralised wastewater treatment system. However, toilet pits available in Pussellawa town are totally lined (due to shallow water table) with single compartment. These storages overflowed or opened, after a temporary storing period, into the drain canals. The wastewater disposal from the town has led to significant increase in the pollutant level ($P < 0.01$ for both total Coliform and E. coli) at outflow from town when compared with inflow water quality into the town (Figure 15.1). Additionally, high population density produces and directly disposes massive pollutant loads from a small area where there is no sufficient space and time for natural treatment to take place. The main reason for this type of environmental disaster is unorganized urbanisation including inappropriate town/city planning and inappropriate living conditions and livelihood.

Rothschild Estate contributes to surface water pollution with the existing wastewater disposal mechanisms. The estate community (100 per cent) disposes their grey-water from kitchen and wastewater generated from bathing and washing clothes directly into nearby drainage system. Grey-water also contains faecal pollutants as a result of communities washing even clothes that are smeared with childrens' stools. Among the studied population, 21 per cent of the population includes children less than 5 years. All the toilets in the estate dispose the faecal matter to unlined cesspits. Unavailability of toilets in public places as school (where the most of estate children are present during the school hours) and working field (no toilet facilities available in tea estates) have led to open defecation. Black Forest Colony residents, basically villagers, have individual toilets per family with septic tanks or cesspits. Therefore, surface water pollution is comparatively less among village communities of Black Forest Colony.

Deterioration of Groundwater

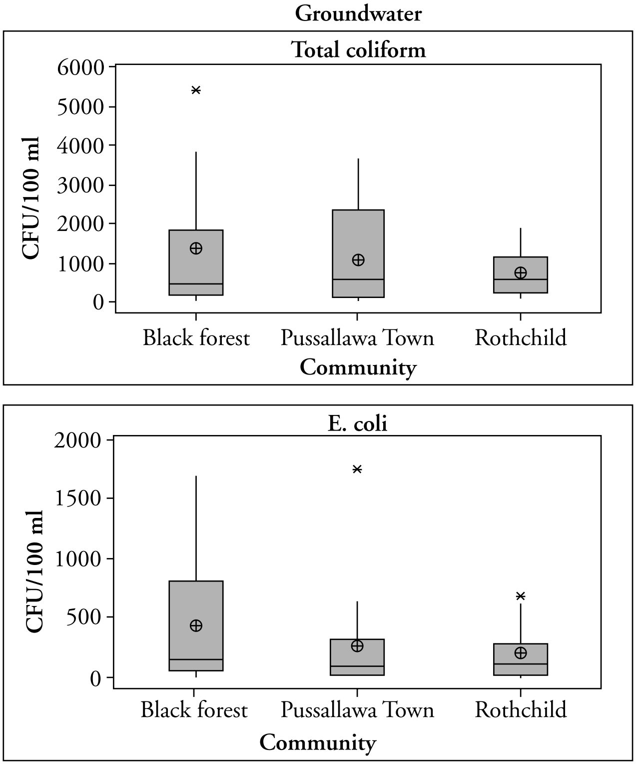
The average groundwater quality variation among the three different communities is shown in Figure 15.2. The groundwater pollution in the Black Forest community is found to be comparatively higher (Total Coliform–1412 CFU/100ml and E. Coli–441 CFU/100ml) than the other two communities (Pussellawa town: Total Coliform–1068 CFU/100ml and E. Coli–287 CFU/100ml. Rothschild Estate: Total Coliform–737 CFU/100ml and E. Coli–200 CFU/100ml). Possible reasons for poor quality inflow could be recharge of contaminants into the groundwater storage and availability of unsuitable latrine pits in the area. Groundwater existence is limited in Black Forest area that is available only in the valley closer to the stream. People reside in the valley, live very close to the stream and their toilet pits are also located in the same area. These toilet pits contribute much to contaminate the limited groundwater source available. On the other hand, the groundwater withdrawn from wells is water that is recharged by the stream.

The second highest groundwater pollution is found from Pussellawa Town area (Figure 15.2). Unlined cesspits and drainage canals cannot be used in this area due to seepage from shallow groundwater (a few cm from the land surface). Therefore, the toilet pits are completely lined with a single compartment and the city drainage canals are also totally lined within the city limits. Leakage through these linings might be the cause of existing pollution in the groundwater within the city limit. On the other hand, potential for groundwater contamination through leakages of the cesspits/drainage canals is minimal due to the negative hydraulic gradient often exist towards groundwater.

Case Study 2: Selected PHI Areas from Kurunegala District

This case study was carried out in four PHI areas in Kurunegala district, namely Alawwa, Kudagalgamuwa, Kurunegala and Narammala (Map 15.2) to study the risks from water-related diseases in the area.

Figure 15.2: Groundwater Contamination in Black Forest Colony, Pussellawa Town and Rothschild Estate Communities

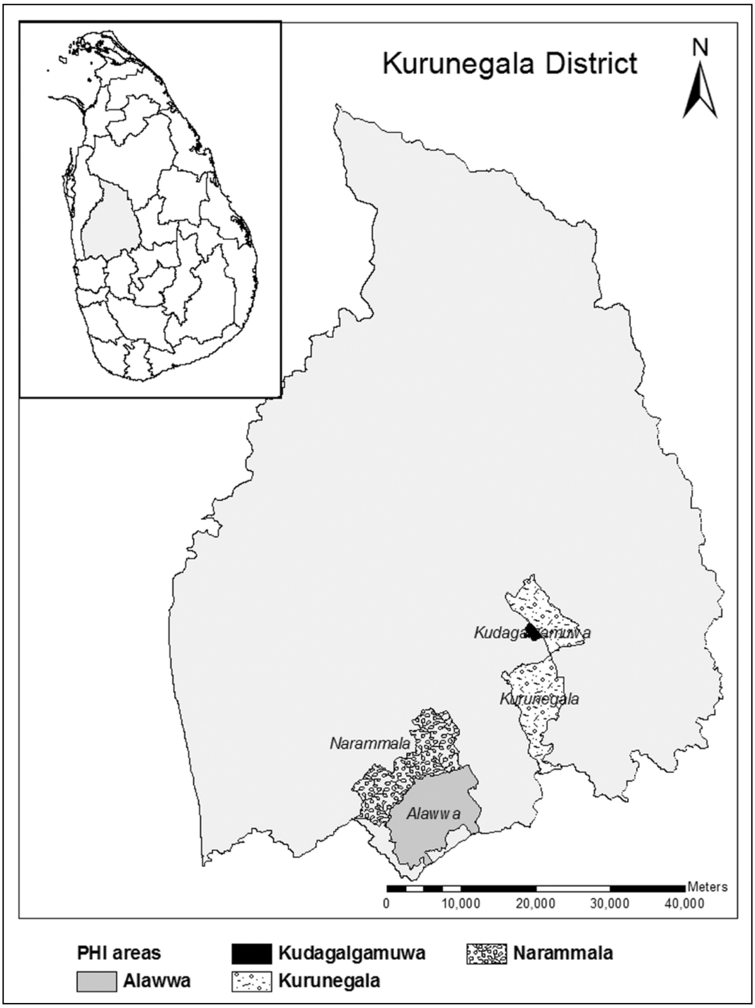


Deterioration of Health

Most prevalent water related diseases in Alawwa, Kudagalgamuwa, Kurunegala and Narammala PHI areas (Figure 15.3) were assessed using the government health statistics. Some of the cases were not reported at the provincial Ministry of Healthcare as they were mild infections and treatment was sought in private hospitals.

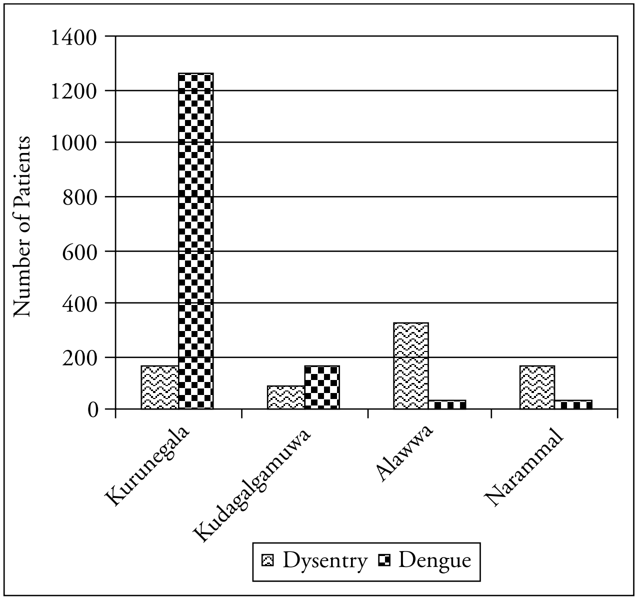
Kurunegala municipal council area is identified as one of the high risk areas for dengue fever (DF) and dengue hemorrhagic fever (DHF) infections. This high incident could be due to improper solid waste disposal and/or availability of breeding sites in the densely populated city and peri-urban areas.

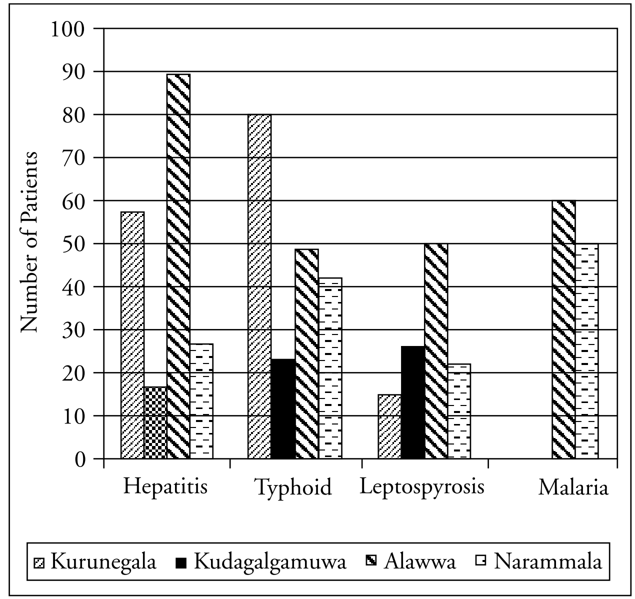
Map 15.2: Alawwa, Kudagalgamuwa, Kurunegala and Narammala PHI areas



The water related disease that is most prevalent after dengue is dysentery. Alawwa is the area that recorded maximum dysentery cases followed by Narammala and Kurunegala. Most of the Alawwa (62 per cent) and Narammala (51 per cent) residents use wells for potable water supply. A very small number of housing units are supplied with

Figure 15.3: Water-related Diseases Reported at Different PHI Areas from 1996 to 2007





water by the authorities. Water wells that supply potable water could be contaminated due to poor sanitary facilities and their management. Most of the Kurunegala city is covered by the NWSDB water supply where 90 per cent of the population and 100 per cent of the area is covered (Jayakody et al. 2006). Kudagalgamuwa, a rural area without a dense population, recorded least number of infected patients. This could be due to least opportunity of water sources contamination (sufficient spacing between sanitation installations and water wells), lower groundwater table, and so on.

Alawwa recorded the highest incidence of hepatitis and dysentery from the study areas. This is reflected by the poor sanitation coverage in the area. About 10.2 per cent of the houses in Alawwa do not have toilets and 34.3 per cent do not have sufficient sanitation facilities. Only 55.5 per cent of the houses have water sealed toilets. The highest number of leptospirosis and malaria cases were also reported from Alawwa area. The highest number of dengue and typhoid cases were recorded from Kurunegala PHI area. Kudagalgamuwa, an area which is not densely populated, recorded the least number of hepatitis, dysentery and typhoid cases. This is an indication that the water sources used in this area are less prone to faecal pollution.

Other Water Pollution Records in Sri Lanka

Deterioration of Groundwater

In highly populated urban and rural areas, groundwater pollution is reported due to poor location as well as inappropriate designs, constructions and maintenance of septic tank systems. Larry and Robert (1985) have reported that areas with more than 40 septic tanks per square mile can be considered to have potential contamination problems. In these densely populated centres, toilet pits or septic tanks are made very close to each other and even very close to wells due to limitation of land. Other than that storm-water drainage canals in these cities, mostly unlined and collecting the domestic and municipal wastewater, sewage through overflowing of toilet pits or direct discharge of toilet wastes act as a very good source of pollution of the adjacent wells with recharge.

The population density in wet zone is about 957 persons/ sq. km whereas in the dry zone it is as low as 163 (Werellagama et al. 2003). But the population centres in the eastern part of the country are very high, for example, Sainthamaruthu District Secretariat division has 2,725 persons/sq. km). Nawas (2006) reported that 367 sq. m land area is available per person in Sainthamaruthu, 66 per cent families have only a dwelling area of 6.6–19.0 sq. m, 12 per cent families have only 6.6 sq. m or less, while majority (48.5 per cent) of the families possesses between 6.6–17.7 sq. m of land compared to the national figure of 3,453 sq. m. Meanwhile, the actual land area per person in Sainthamaruthu is 40 sq. m (Nawas 2006). Septic tank density in Sainthamaruthu is 5,432/sq. km (Nawas et al. 2006) and well density is 4,428/sq. km. Both wells and septic tanks are located in the same area (Nawas et al. 2005). Werellagama et al. (2003) agreed to the recommended distance of a minimum 15 m between a dug well and a septic tank system. However, the radial distances noted in Sainthamaruthu were less than 15 m between a well and a septic tank (Nawas 2006).The highly permeable sandy regosol soil will simply allow wastewaters to leach back to groundwater system.

The case study of Pussella Oya catchment shows groundwater pollution when cesspit systems are installed closer to wells similar to the findings by other researchers such as Werellagama et al. (2003) and Nawas et al. (2005 and 2006).

Deterioration of Health due to Water-related Infectious Diseases

According to Rajapakshe et al. (2007) in areas adjacent to Wilgoda Anicut and surrounding canals in Kurunegala municipality, water-related vector borne diseases like Dengue and Filariasis were reported due to polluted water or improper management of water. This area is recorded as endemic for filarial disease. Both DF and DHF continue to be major public health problems in Sri Lanka. The worst ever epidemic of DF and DHF was recorded in 2004 in which there were 15,467 suspected cases and 88 deaths.

Sri Lanka faced a Chikungunya fever outbreak in 2006. The most affected areas for the outbreak were Puttalam (11,125), Kalmunai (4,092), Colombo (5,286), Jaffna (1,512), Mannar (9,255), Batticoloa

(3,141) and Trincomalee (1,910). Over 37,600 suspected cases were reported from the country by the end of 2006.

The most prominent water-based disease reported from Sri Lanka is Leptospirosis, a bacterial disease, which rapidly spread to all the Deputy Provincial Director of Health Service (DPDHS) division in Sri Lanka (MHN 2007). It was an endemic disease in many parts of Sri Lanka. In 2006, 1,192 confirmed cases were reported to the epidemiology unit (MHN 2007). Actual incidence of Leptospirosis is likely to be more than this as many patients with mild form of the disease did not seek treatment at all or were treated by private practitioners.

Most of the Leptospirosis cases were reported in Gampaha district in September 2005 and September 2006.The disease occurrence had been high during March–June and in the latter part of the year. About 84 per cent cases in the country and over 90 per cent in Gampaha have been men. The evidence shows the vulnerability of men in the productive age groups (MHN 2007). Paddy cultivation is common in most of the endemic areas and the peak incidence is seen during the paddy harvesting seasons due to an increase in rodent population in and around paddy fields. Paddy fields (46 per cent) and marshy muddy lands (35 per cent) have been identified as the commonest probable source of infection in Gampaha (MHN 2007). Wastewater discharge will enhance the wetness or muddiness of paddy fields creating a better environment for spread of disease .

Case Study 2 from four PHI areas from Kurunegala district shows the spread of water-related diseases. Major reasons behind the disease outbreaks are water pollution, mainly contamination with faecal matter and improper water/wastewater management.

Deterioration of Irrigation Water

Tolerance limits are available for industrial effluents discharged into inland water ways and on land for irrigation purpose in National Environmental (Protection & Quality) Regulation No.1 of 1990. Irrigation water quality guidelines are being developed. Kurunegala city wastewater exceeds the tolerance limits for discharging water to inland water bodies (IEE 2005), but for agricultural use, current discharge quality is well within the range. Microbial water quality in many such drains has exceeded the tolerance limits or allowed limits proposed by the Central Environmental Authority (CEA). Use of polluted water, specially polluted with faecal matter, causes concerns for irrigators and consumers.

Other Water-related Problems

High concentrations of suspended solids in waters due to discharge of partially treated wastewater or illegal raw sewage discharges could impede switching from chlorination to less toxic and less hazardous disinfection methods such as ultraviolet light (Katonak and Rose 2003), which is very expensive for developing nations like Sri Lanka. Availability of organic pollutants in water will also lead to generation of toxic by-products that are carcinogenic if treated with chlorine. Water flow from the study areas presented in Case Study 1 is used for community water supply projects as well as intake for a water supply scheme of NWSDB. Faecal contamination of these sources as reported in the case study might cause many bad impacts on the water supply, purification and the consumers.

Nutrient enrichment in water bodies by domestic wastewater, municipal wastewater, sewage discharges and other inorganic and organic pollutants from industries will lead to eutrophication where toxic algal blooms also grow. Toxic algae in water bodies damages aquatic mammals and birds and affect even humans who may ingest via contaminated aquatic food or inhale through contaminated sprays. It is reported that more than 60,000 human infections occur each year in the US alone due to ingestion of contaminated aquatic food or inhalation of contaminated sprays. In Sri Lanka, however, the number of people affected is not known. Eutrophication in freshwaters is becoming a serious problem in surface water bodies of Sri Lanka in Kotmale (Piyasiri 1995), Kandy lake (Silva 2003), Beira Lake, Kotmale reservoir (UNEP 2001), and so on. Suspended sediment materials reduce light penetration into deep layers of the water body. Moreover, water pollution creates an aesthetically appalling environment emanating bad odour (Rajapakshe et al. 2007).

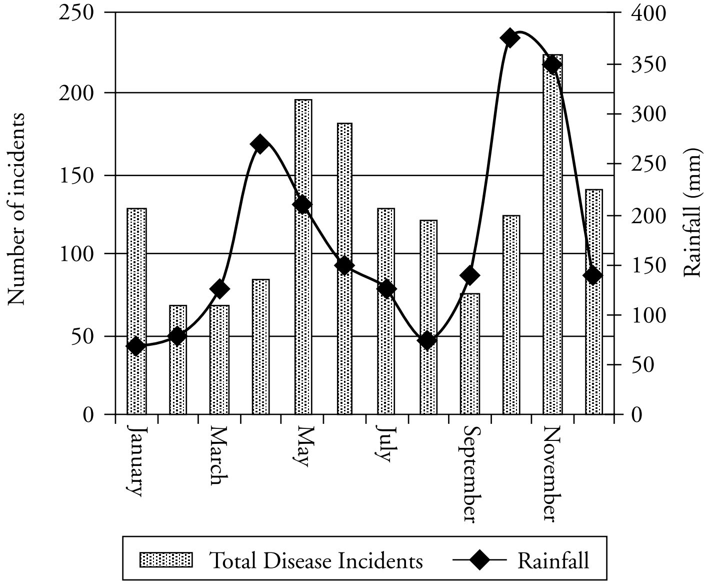
Effect of Rainfall on Disease Spreading due to Wastewater Pollution

Water-related diseases have direct relationship with the rainfall pattern. High incidences of water borne diseases are recorded in the initial part of the rainy season. For example, Hepatitis A outbreak in Gampola in 2007 happened during April–June, the initial part of the South–West monsoon, the main rainy season in the area. Most of the water-related diseases are prominent during the initial part of the South–West monsoon and the main reason is initial rains carrying high pollutant loads with the surface runoff. Studies in Sierra Leone (Wright 1986), Gambia (Barrel and Rowland 1979) and Nigeria (Blum et al. 1987) have all shown the highest faecal coliform counts in surface water sources after the start of the rainy season. The run-off due to high intensity rainfall from faecal polluted soil is one of the major reasons for the high faecal coliforms in surface water bodies that are responsible for water-borne diseases.

Total number and variety of disease incidents recorded at Alawwa, Kudagalgamuwa, Kurunegala and Narammala PHI areas are shown in Figures 15.4 and 15.5, respectively. The diseases are more concentrated in the periods from May to August (South–West monsoon) and November to January (North–East monsoon). The findings show that the most disease incidents are concentrated within the period just after the peak rainy seasons and during the inter-monsoonal seasons. Dengue appears the highest number of times from May to August (South–West monsoon) and from November to January (North–East monsoon). North–East monsoon reported sharp increases in DH and DHF cases in all the PHI areas studied that could be attributed to the heavy rainfall received throughout the North–East monsoon.

Dysentery is recorded mostly during May to August (South–West monsoon) and October to November (second inter-monsoon). The lowest incidents recorded are from December to April (North–East monsoon and the first inter-monsoon) and the month of September. Leptospirosis is prominent in the months of February, harvesting period of Maha season and October (just after harvesting period of the Yala season). Typhoid shows the lowest occurrence from February to April (first inter-monsoon). Other than the above differences,

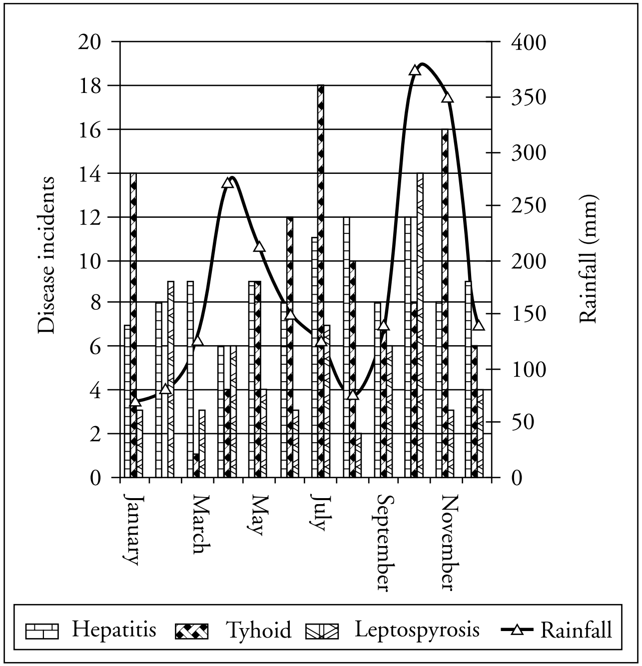
Figure 15.4: Total Number of Disease Incidents in Alawwa, Kudagalgamuwa, Kurunegala and Narammala Areas

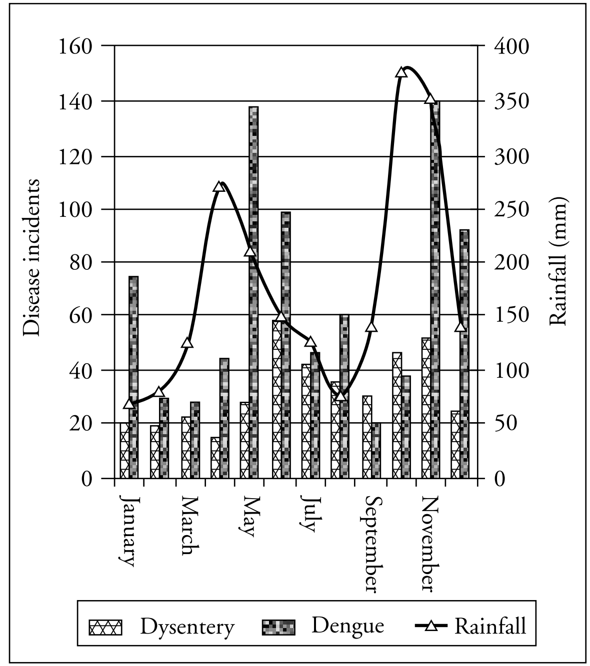


Leptospirosis, Typhoid and Hepatitis do not show any significant patterns in the distribution.

Alawwa PHI area has recorded the highest number of Hepatitis cases during the rainy seasons. The main source of water supply to Alawwa is the Maha Oya and the water is supplied by treating with chlorine disinfection alone. Alawwa PHI area has 172 houses without any toilets and due to the open defecation the water source could be infected with faecal pollutants. In Narammala, water supply source is groundwater abstracted by tube wells. During rainy season the groundwater table increases beyond the toilet pits promoting the transmission of bacteria to the water wells. Groundwater contamination due to high density of population has been discussed by Nawas et al. (2005). Majority of the people live in Narammala PHI area use shallow water wells which could be contaminated with the faecal pollutants very easily. Water table rises beyond the toilet pit levels during the rainy season leading to groundwater contamination.

Figure 15.5: Types of Diseases in Alawwa, Kudagalgamuwa, Kurunegala, and Narammala Areas





Institutional and Policy Implications in Wastewater Management

The NWSDB, whose mission is to 'save the nation by providing sustainable water and sanitation solution ensuring total user satisfaction', is responsible for water supply and is in charge of the sewerage systems in Colombo, suburbs and other cities. Only a part of Colombo city has a sewerage system other than very small localised systems in the country. The sewerage network is limited to a small area serving approximately 25 per cent of Greater Colombo, and a large section of it is old and not operational. Built between 1906 and 1920, some parts of the system need urgent repair.

The sewerage system in Colombo is traditionally operated and maintained by the Colombo Municipal Council (CMC). Although NWSDB is the owner of the sewerage system, Operation and Maintenance (O&M) has been undertaken primarily by CMC with no contractual agreement between NWSDB and CMC that specifies performance standards and penalties for non-performance. There are no clear institutional arrangements for maintaining and operating the system. With no sewerage tariff being charged to water users connected to the system, CMC relies heavily on property taxes to help pay for O&M of the system.

The NWSDB initiated projects with foreign funding to install sewerage systems in Kandy and Kurunegala cities but these projects are yet to start operation due to difficulties such as allocation of land, opposition by the stakeholders, lack of support from other organisations, and so on. This delay in centralised wastewater systems is mainly due to the bad experience people have from the already installed systems in Colombo and in hospitals which are not functioning due to poor O&M, because of financial shortage.

Other than the NWSDB, the wastewater management is considered as one of the responsibilities of municipalities, urban councils or village councils known as Pradeshiya Sabha. In order to support these institutions, Sri Lanka Standard Institution (SLSI) has established guidelines (SLS 745–2003) for the design and construction of septic tanks and associated effluent disposal systems. In addition, the establishments of the CEA by an act known as the National Environmental

Act (Act No. 47 of 1980) and related amendments have given the legal framework needed in water pollution control and mitigation. The act has introduced National Environmental (Protection and Quality) regulations. According to the act and the regulations, the polluters have to obtain an Environmental Protection License (EPL) and need to make sure the effluents discharged meet predetermined quality standards.

The major polluters from Case Study 1 are the low income estate workers who reside within the tea or rubber estates. SLS 745–2003 is not implemented in the estate sector and the unavailability of proper sanitation facilities increases the pollution risk of the streams which are acting as the sink. Due to unavailability of safe water supply, the downstream low income communities utilise the contaminated flows for their domestic use. In Case Study 2, there are many polluters, namely low income communities, ignorant households, small industries and some service providers. The service providers and the small industries need to obtain EPL and the compliance is somewhat ensured through the local authority and environmental officers. Unfortunately, SLS 745–2003 is not implemented at all due to which the faecal pollution is a concern in some parts of the urban areas.

Even though the standards and regulations mentioned above exist, the major problem is the lapses in the implementation. The construction of septic tanks or related effluent disposal mechanisms is not monitored and there is no means of regulating the construction even though the prescribed standards are there. Once a polluter obtains EPL, there is hardly any monitoring to see whether the polluter is sticking to the discharge standards. In addition, the central wastewater system or the sewer system in Colombo is overloaded due to illegal connections given by interested parties due to wide-spread corruptions in the system.

The local government authorities responsible for issuing licenses for constructions or approving plans of buildings do not consider the land availability or zoning. This is mainly due to unavailability of a town plan or a town planning unit or experts on the subject. These authorities do not have a mechanism to implement standards on wastewater disposal such as SLS standard 745–2003.

The surface and groundwater resources come under different ministries, departments, authorities and institutions. Due to the nature of the cross institutional interests, the responsibilities are not taken by one institution leading to deterioration of the water resources. As there is no water management act in the country, the responsibilities are not vested on a particular department or ministry. This has led to the water pollution issues remaining unattended, thereby worsening the health implications as highlighted through case studies in this chapter.

Conclusions

Population growth and urbanisation generate massive quantities of wastewater, thereby weakening the natural wastewater treatment capabilities. Although the SLSI has established guidelines for the design and construction of septic tanks and associated effluent disposal systems, faecal contamination in many areas is attributed to poor attention paid to local soil conditions, groundwater table, urban congestion and lack of awareness of implementers and regulators on appropriate alternative cost-effective means of effluent disposal systems. Groundwater pollution is proving to be a disaster with the use of unsuitable technologies for excreta disposal and poor construction and maintenance of excreta disposal mechanisms.

Non-implementation of the proposed standards is blamed on ineffective bureaucracy, poor motivation of the field staff and financial constraints in the implementation process.

Urban and peri-urban town communities are the highest polluters in Sri Lanka. The main reason for this condition is unorganised urbanisation, including inappropriate town or city planning and inappropriate living conditions and livelihood. Urban and peri-urban town communities are highly vulnerable to water-related vector-borne diseases like DF due to poor solid waste and wastewater management practices. Water-borne diseases are negligible within the urban and peri-urban town communities which are supplied with safe drinking water. However, water-borne diseases are reported from areas with very high population density and where water from untreated natural water sources such as shallow dug and tube wells are used. The problems of urbanisation on wastewater management can be minimised by better country or town planning with adequate consideration to water supply and sanitation.

There are many institutional arrangements, Acts, regulations and standards in Sri Lanka but water pollution, both of surface and groundwater, and related health implications continue to increase due to non-implementation or monitoring of the pollution. It is necessary to coordinate among the responsible departments to deal with the issue of preventing or controlling water pollution and related problems. There are attempts by some projects funded by the public sector and also some initiatives by NGOs to change the situation. These projects attempt to improve water supply and sanitation through means of introducing better management practices such as upper watershed management, alternate technologies like ecological sanitation, water treatment facilities for service providers, and so on which have improved the situation at the grassroots level.

References

ADB, 2006. *Urbanization and Sustainability: Case Studies of Good Practice*. Manila: Asian Development Bank.

Barrel, R.A.E. and M.G.M. Rowland. 1979. 'The Relationship between Rainfall and Well Water Pollution in a West African (Gambian) Village', *Journal of Hygiene*, 83(1): 143–50.

Blum, D., S.R.A. Huttly, J.I. Okoro, C. Akujobi, B.R. Kirwood, and R.G. Feacham. 1987. 'The Bacteriological Quality of Traditional Water Sources in North–Eastern Imo State, Nigeria', *Epidemiology and Infection*, 99(2): 429–37.

DCS. 2001. 'Census of Population and Housing 2001: Kurunegala District – Final Results (CD)'. Sri Lanka: Department of Census and Statistics.

IEE. 2005. 'Initial Environmental Examination Report in Respect of Greater Kurunegala Sewerage Project', International Institute for Environment and Development, Ministry of Urban Development and Water Supply, Sri Lanka.

Jayakody, P., L. Raschid-Sally, S.A.K. Abayawardana, and M.M.M. Najim. 2006. 'Urban growth and wastewater agriculture: A study from Sri Lanka', Paper presented at 32nd WEDC International Conference, Colombo, Sri Lanka.

Katonak, R. and J.B. Rose. 2003. *Public Health Risks Associated with Wastewater Blending*'. East Lansing: Michigan State University.

Larry, W.C. and C.K. Robert. 1985. *Septic Tank System Effects on Groundwater Quality*. Bosa Roca, USA: CRC Press.

MHN. 2007. 'Sentinel Surveillance of Leptospirosis', Weekly Epidemiological Report, 34(24):1–4. Epidemiological Unit, Ministry of Healthcare and Nutrition, Government of Sri Lanka, Colombo, Sri Lanka.

Nawas, M.F., M.I.M. Mowjood, and L.W. Galagedara. 2005. 'Contamination of Shallow Dug Wells in Highly Populated Coastal Sand Aquifer: A Case Study in Sainthamaruthu, Sri Lanka'. *Tropical Agricultural Research*, 17(1): 114–24.

———. 2006. In print. *Sustainable Use of Groundwater in Highly Populated Areas of the Coastal Belt of Sri Lanka*', in A.M.O. Mohamed (ed.), *Arid Land Hydrogeology: In Search of a Solution to a Threatened Resource.* The Netherlands: Taylor & Francis/Balkema, pp. 45–50.

Nawas, M.F. 2006. 'Groundwater Pollution and Its Effects on Public Health in a Highly Populated Area: A Case Study in Sainthamaruthu in Kalmunai M.C.' M.Phil. Thesis. Postgraduate Institute of Agriculture, University of Peradeniya.

Piyasiri, S. 1995. 'Eutrophication and Algae Bloom Problem in Kotmale Reservoir, Sri Lanka', in K.H. Timotius and Goltenboth (eds), *Tropical Limnology*, Vol II. Salatiga, Indonesia: Satya Wacana University Press.

Rajapakshe, I.H., I.P.P. Gunawardana, and M.M.M. Najim. 2007. 'Problems Associated with Utilization and Management of Wastewater: A Case Study from Sri Lanka', *The Environ Monitor*, 7(11): 4–13.

Shanmugarajah, C.K. 2002. 'Health, Water and Sanitation', in K.A.U.S Imbulana, P. Droogers, and I.W. Makin (eds), *World Water Assessment Programme: Sri Lanka Case Study*, pp. 97–105. Ruhuna Basins.

Silva, E.I.L. 2003. 'Emergence of a Microcystis Bloom in an Urban Water Body, Kandy Lake, Sri Lanka', *Current Science*, 85(6): 723–25.

SLSI. 2003. *Draft Sri Lanka Standard: Code of Practice for the Design and Construction of Septic Tanks and Associated Effluent Disposal Systems*. Colombo: Sri Lanka Standards Institution.

UNEP. 2001. *Sri Lanka: State of the Environment 2001*, United Nations Environment Programme, pp. 53–67. Available online at http://www.rrcap.unep.org/reports/soe/srilankasoe.cfm. Downloaded on 16 December 2008.

Van der Hoek, W. 2004. 'A Framework for a Global Assessment of the Extent of Wastewater Irrigation: The Need for Common Wastewater Typology', in C.A. Scott, N.I. Faruqui, and L. Raschid-Sally (eds). *Waste Water Use in Irrigated Agriculture Confronting the Livelihood and Environmental Realities*, CAB eBook, DOI 10.1079/9780851998237.0011, pp. 11–23. CABI

Werellagama, D.R.I.B., G. Herath, M. Hettiarachchi, and S. Basnayake, 2003. 'Report on Recommendations and Suggestions on the Standard Distance between a Potential Faecal Pollution Source and a Drinking Well in Sri Lanka', *Water Quality Sri Lanka*, NetWater, Sri Lanka.

WHO. 2002. 'Reducing Risks, Promoting Healthy Life', in *World Health Report 2002.* Geneva: WHO.

World Bank. 2005. *World Development Indicators 2005*. Washington, D.C.: World Bank

Wright, R.C. 1986. 'The Seasonality of the Bacterial Quality of Drinking Water in Sierra Leone', *Journal of Hygiene*, 96(1): 75–82.