Estimating the costs of diarrhoea and epidemic dysentery in KwaZulu-Natal and South Africa

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Abstract

Inadequate water supply and sanitation are largely responsible for the high levels of diarrhoeal disease in developing countries. With more than 12 m. people without adequate levels of water supply and sanitation, South Africa is no exception. This paper presents a preliminary screening assessment of the impacts and costs of diarrhoeal disease in South Africa, which indicates that every year in South Africa about 43 000 deaths, 3 m. incidences of illness requiring treatment and R3.4 bn. may be directly attributed to diarrhoeal disease. It also indicates that the current *Shigella dysenteriae* type 1 epidemic in KwaZulu-Natal may have cost about R120 m. and caused 1 000 deaths during 1995. This re-emphasises the need for urgent action in the provision of water supply and sanitation infrastructure, together with appropriate hygiene education and health services, to all disadvantaged South Africans.

Introduction

It is estimated that there are more than 800 m. cases of diarrhoea every year in developing countries, causing up to 4.5 m. deaths (Esrey et al., 1990). South Africa is no exception, with an estimated 12 m. people without access to adequate water supply and about 21 m. people without safe sanitation (DWAF, 1996). In 1995/96, a *Shigella dysenteriae* type 1 epidemic in KwaZulu-Natal resulted in thousands of observed cases with many hundreds of deaths (CDC, 1996; Rollins, 1996). These staggering numbers have profound consequences for individuals, families and the society at large, in terms of social disruption, lost economic opportunities and health costs. The most defenceless and economically marginal segments of society are usually the most susceptible and therefore suffer the greatest.

To date, no South African studies have attempted to estimate the socio-economic costs associated with diarrhoeal disease. The quantification of these costs should provide crucial motivation to guide the allocation of resources in combating the incidence of diarrhoeal disease.

The purpose of this paper

The objective of the investigation described in this paper was to identify the social and health impacts, and where possible to quantify the costs of diarrhoeal disease and the *Shigella dysenteriae* type 1 (SD1) epidemic in KwaZulu-Natal and South Africa during 1995. SD1 causes a particularly virulent form of dysentery, which has recently emerged as an epidemic throughout KwaZulu-Natal and the Eastern Cape, with cases being observed in the Western Cape and Mpumalanga (Rollins, 1996). The diarrhoeal analysis provides an indication of the ongoing impacts of inadequate infrastructure, hygiene and health services, while SD1 reflects epidemic consequences.

Time and data constraints limited the investigation to a rapid screening assessment of the situation, based on the expert opinion of health practitioners, supported by South African and internationally published data. Therefore, the results should be viewed as order-of-magnitude estimates which require further detailed study. Despite the relative size of the resulting cost estimates, these are likely to err on the conservative side, due to the generally conservative values used in the assessment and the exclusion of those costs which could not be estimated.

Background

Diarrhoea is usually defined as three or more watery stools passed in 24 h. Children under 5 years of age living in settlements with rudimentary access to water supply and sanitation are the most susceptible to the ravages of diarrhoea (Esrey et al., 1990). The international experience indicates that diarrhoeal incidence rates are about 5 times higher for children under 5 years, living in settlements with water supply and sanitation below levels equivalent to those specified by the DWAF (1995) for the Reconstruction and Development Programme (RDP), when compared to children in formal urban residential areas with in-house connections, whereas the diarrhoeal mortality rates may be 500 times higher (Victoria et al., 1988; Payment et al., 1991; Tonglet et al., 1992). In addition to water supply and sanitation infrastructure, other factors such as household income, maternal education, level of housing, nutritional status and access to health services also affect the morbidity and mortality levels associated with diarrhoeal disease (Feachem et al., 1978; Wibowo and Tisdell, 1993).

Diarrhoea may be transmitted by poor water quality, either directly in water supply or through contact with contaminated environmental water resources (e.g. swimming in rivers), but this is not usually the main route. Transmission via hands, food, eating utensils, insects (flies) and contaminated soil, together with direct personal contact with an infected person, seem to be far more significant (Feachem et al., 1978). This has led to the realisation that the quantity of water used and the safe disposal of sanitation by a household is of greater importance than the quality of water, as long as water sources are not directly contaminated

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(Esrey and Habicht, 1986).

Dysentery is the frequent passing of bloody stools, and SD1 results in severe epidemic outbreaks (Ries, 1996; Rollins, 1996). SD1 is a highly virulent bacterium causing dysentery with high mortality rates and similar transmission routes to other diarrhoeal diseases. However, transmission through the environment is less significant, because the organism is not robust outside of the host, whereas direct personal contact and contaminated food provide the main pathways for transmission.

The nature and transmission routes of diarrhoeal disease, including dysentery, have implications for the type of health, educational, social and infrastructural interventions which are appropriate. They also indicate the need for integrated multi-sectoral strategies to address the problem. Planning and provision of water supply and sanitation infrastructure represents a central component of this integrated strategy (GNU, 1995).

The approach used

A number of methodologies have been proposed for environmental valuation, which include estimation of the costs of morbidity and mortality resulting from illness. The commonly applied approaches for social and health cost estimation are based either on the willingness-to-pay (WTP), including willingness to accept compensation, or on the cost-of-illness (COI) approach. The former attempts to quantify the value that individuals place on illness (or to avoid illness) and is favoured by many economists, because it reflects the economic theory of individual preferences.

The COI approach is based on the estimation of the direct and indirect costs associated with illness, which need resources to be redirected away from other beneficial uses (opportunity cost). As such it provides a more objective means of quantifying costs. It was chosen for this study, because it is more appropriate given the limited data and previous studies available, and is more applicable to the developing country socio-economic context of rural KwaZulu-Natal (and South Africa as a whole). The data requirements for WTP studies are far greater and introduce the equity-based problems of ability to pay by poor communities.

The total cost of diarrhoeal disease (and dysentery) may include (Paul and Mauskopf, 1991):

- **Direct costs** of medical resources used in treatment of the disease, including costs of self-treatment to individuals (or households) and government expenditure.
- **Indirect costs** for households associated with lost economic opportunities caused by illness or death, due to reduced productivity of the victim or family care-providers, in both the short and long term.
- **Other direct costs**, such as transportation to health services and household costs to accommodate the needs of the affected person.
- **Social costs**, such as both short- and long-term quality of life reductions associated with the pain and suffering from illness or death caused by the disease.
- **Overall costs to the economy** reflecting the impact on the gross national product due to reductions in productivity and allocation of limited resources to health care.

The data and analysis required to estimate all these costs are prohibitive, which usually results in the estimation of only the "core" costs of illness represented by the first two groups. This study was limited to estimates of only short-term (duration of illness) "core" costs and direct transport costs, which implies that the resulting estimates should be conservative. Furthermore, for ethical reasons, no attempt was made to estimate the value of life, so the significant direct and indirect (opportunity) cost of death from diarrhoeal disease (or dysentery) has been excluded, which potentially makes the cost estimate even more conservative.

Thus the approach used assumes that the short-term core costs reflect the actual costs of illness and that the limited data available reasonably represent the existing situation. Conservative values were used throughout the analysis in order to provide lower bound estimates, rather than attempting to develop definitive values which cannot be supported by the limited data available. In summary, although the approach is not perfect, it provides the best available means of indicating the order of magnitude of the required information.

Five basic steps are required to apply the COI approach for assessing the impacts of diarrhoea (and dysentery) in KwaZulu-Natal and South Africa.

(i) Estimate the demographic distribution of people within different age groups (i.e. <5 years, 5 to 16 years and >16 years), associated with various levels of water supply and sanitation infrastructure (i.e. <RDP, >RDP and formal on-site).
(ii) Estimate incidence rates of mortality and severity of morbidity (i.e. mild, moderate or severe) for each age grouping associated with each level of water supply and sanitation infrastructure in (i)
(iii) Estimate the impact of an incident at each severity level in (ii) on productivity (i.e. lost days), health services (i.e. visits and/or days) and transport to health services (i.e. trips).
(iv) Estimate the unit cost (i.e. R/d or R/visit) associated with each of the impacts identified in (iii).
(v) Combine the demographic information with the incidence, impacts and cost estimates to calculate the direct health and transport costs, and indirect short-term opportunity costs.

The analysis was performed for diarrhoea in KwaZulu-Natal and for South Africa as a whole, and dysentery only in KwaZulu-Natal. South African estimates for incidence (i), impacts (ii) and health costs (iii) were based on data from King Edward Hospital in Durban, personal surveys and expert opinion provided by the second author and two other South African doctors (Wittenburg, 1996; Robinson, 1996), who have been involved in treating and researching diarrhoeal disease in South Africa for a number of years. These estimates were validated against other South African (Von Schirnding et al., 1993; Robinson, 1992 and 1993) and international studies where possible (Victoria et al., 1988; Payment et al., 1991; Tonglet et al., 1992). The costs of lost workdays (iii) and the demographic information (iv) were based on a synthesis of the South African Central Statistical Services information (CSS, 1996), Eskom survey results (Eskom, 1996) and the Department of Water Affairs and Forestry (DWAF) Community Water Supply and Sanitation Planning Study (DWAF, 1996).

Demographic information

An indication of the assumed demographic distribution of people affected by diarrhoea in KwaZulu-Natal and South Africa is presented in Table 1, based on Eskom (1996) and DWAF (1996). The definition of different water supply and sanitation (WSS) categories is based in the DWAF National White Paper (DWAF, 1995) on Community Water Supply and Sanitation (WSS):

TABLE 1
DEMOGRAPHIC INFORMATION (POPULATION) USED FOR KWAZULU-NATAL AND SOUTH AFRICA

	KwaZulu-Natal		South Africa	
< 5 years (child)	1 300 000	15%	6 000 000	14%
5-16 years (school child)	2 400 000	28%	11 600 000	28%
> 16 years (adult)	4 950 000	57%	24 400 000	58%
< RDP Water and Sanitation	3 000 000	35%	12 600 000	30%
> RDP Water or Sanitation	2 600 000	30%	12 600 000	30%
On-site (formal)	3 050 000	35%	16 800 000	40%
Total	8 650 000	100%	42 000 000	100%

TABLE 2
DIARRHOEAL AND SD1 DYSENTERY MORBIDITY SEVERITY AND MORTALITY INCIDENCE RATES FOR DIFFERENT WSS CLASSES AND AGE GROUPS (# PER 1000)

Water supply and sanitation infrastructure	Age	Diarrhoea (incidents per 1 000 people)				SD1 Dysentery (incidents per 1 000 people)[1]			
		Morbidity			Death	Morbidity			Death
		Mild	Mod.	Severe		Mild	Mod	Severe	
< RDP Water and Sanitation	< 5	2000	375	125	15	12	20	8	0.8
	5 - 16	900	80	20	0.5	12	20	8	0.8
	> 16	675	60	15	0.15	16	20	4	0.6
> RDP Water or Sanitation	< 5	1275	165	60	3	4.5	4.5	1	0.1
	5 - 16	450	42.5	7.5	0.1	4.5	4.5	1	0.1
	> 16	225	21	4	0.025	5	4.5	0.5	0.008
On-site Water and Sanitation	< 5	450	40	10	0.5	0.05	0.045	0.005	0.001
	5 - 16	238	11	1	0.025	0.05	0.045	0.005	0.001
	> 16	95	4.5	0.5	0.005	0.05	0.045	0.005	$5x10^{-5}$

[1] The dysentery incident rates are associated with an epidemic, and are not ongoing as is the case with diarrhoea.

- **RDP WSS**: represents a reliable supply of water within 200 m of each household, providing 25 l/capita·d, with at least a ventilated improved pit latrine per 6 to 8 people (or household).
- **On-site WSS**: represents a reliable supply of water directly to the household (within or directly outside the dwelling), with on-site flushing sanitation, such as water-borne sewerage or septic tanks.

The first WSS group (<RDP) represents those people with lower than RDP water supply *and* sanitation infrastructure, while the second WSS group (>RDP) represents those with RDP water supply *or* sanitation. This reflects the situation that people with higher levels of water supply and/or sanitation (which is usually accompanied by other factors such as education and income) are less affected by diarrhoeal disease. The three age groups were chosen to reflect the differential susceptibility of young children to diarrhoeal disease, as well as to differentiate the potential productivity losses for schoolchildren and adults.

The high proportion of children presented in Table 1 reflects the highly skewed age distribution in South Africa, while the distribution of people with access to different levels of WSS infrastructure highlights the high percentage without access to rudimentary RDP levels. This distinction between age groups and WSS infrastructure was necessary, due to the highly differential impacts of diarrhoea and epidemic dysentery on different parts of the population.

Unfortunately, other confounding factors were not included in the analysis, due to data and time constraints. These may include housing type, household income, education, nutritional status and access to health services. However, many of these factors would be reflected in the three WSS groupings.

People living at lower altitudes near the coast are most affected by SD1. This was assumed to include about 60% of the total population of KwaZulu-Natal, and a greater proportion of the urban areas with generally higher levels of WSS infrastructure.

TABLE 3
AVERAGE PERIOD OF ILLNESS IMPACTS (DAYS) ASSOCIATED WITH INCIDENTS OF DIARRHOEA AND SD1 DYSENTERY FOR THE VICTIM AND CARE PROVIDER AT DIFFERENT LEVELS OF SEVERITY AND VICTIM AGE

	Age	Diarrhoea (d)			SD1 Dysentery (d)		
		Mild	Moderate	Severe	Mild	Moderate	Severe
Total period of episode	< 5 > 5	4 2	7 5	11 8	5 4	10 8	17 14
Little impact (no impairment)	< 5 > 5	1.5 1	2 1	2 1.5	1 1	2 2	2 4
Discomfort (25% impairment)	< 5 > 5	2 1	2.5 2	2 2.5	2 2	3 2	4 3
Restricted activity (75% impairment)	< 5 > 5	0.5 0	2 1.5	5 2	2 1	3.5 2	6 4
Incapacitation (100% impairment)	< 5 > 5	0 0	0.5 0.5	2 2	0 0	1.5 2	5 3
Total non-productive patient time	< 5 > 5	0.9 0.3	2.6 2.1	6.3 4.1	2 1.3	4.9 4	10.5 6.8
Total non-productive care provider time	< 5 > 5	1 0	2.5 1	5 2.5	2 0.2	4 2.5	8 4

Incidence rates

Table 2 presents the morbidity and mortality incidence rates used in the assessment, according to the WSS infrastructure classes and age groupings outlined above. This information was based on published incidence rates, where available (Wittenberg, 1996; Von Schirnding et al, 1993; Tonglet et al, 1992; Payment et al., 1991; Victoria et al., 1988; CDC, 1996), which were modified for local conditions to provide rates for the WSS and age groups, according to the observations of the doctors referred to above. Despite the lack of reliable data, identification of these incidence rates is critical to the estimation of the impacts of diarrhoeal disease. Thus an attempt was made to use values which were relatively conservative.

The classification of illness into the three morbidity severity classes was based on the clinical symptoms of the patient to diarrhoea and SD1 and reflects the types of treatment required:

- **Mild**: diarrhoeal cases have loose stools and vomiting, while SD1 cases have bloody stools and mild abdominal pain, without additional complications.
- **Moderate**: diarrhoeal cases are indicated by dehydration requiring oral rehydration therapy, while SD1 cases have bloody stools and systemic upset, such as high fever and loss of appetite.
- **Severe**: diarrhoeal cases present with complications requiring case-specific treatment, while SD1 cases are associated with major complications, such as haemolytic-uraemic syndrome.

These incidence data were used, together with the demographic data presented in Table 1, to estimate the total number of illness occurrences and deaths in each WSS level and age group, associated with ongoing diarrhoeal disease and epidemic SD1 dysentery.

Productivity impacts

Each diarrhoeal or dysentery incident has impacts on the productivity of the victim, as well as on their relatives who provide care at home, transport them to and from health services, or visit them in hospital. Table 3 presents the assumed average impacts of a diarrhoea or SD1 dysentery incident at the three morbidity levels, based on information and observations about the effect of illness provided by Drs Rollins, Wittenburg and Robinson (1996). Adults and children of 5 years and older have similar symptoms, so were grouped together, whereas children under 5 years are more seriously affected.

Total period of episode: indicates the average number of days during which a patient suffers from an incident. This may be separated into time during which there is:

- **little impact**: with no impairment of productivity, usually at the end of the episode;
- **discomfort**: during which activities may be performed, but with a 25% reduction in productivity;
- **restricted activity**: when some activities may be performed, but only at 25% productivity; and
- **incapacitation**: when the patient cannot perform any activities, and is either in bed or in hospital.

TABLE 4
DIARRHOEAL AND SD1 DYSENTERY HEALTH SERVICE AND TRANSPORT IMPACTS AT DIFFERENT LEVELS OF MORBIDITY, SEVERITY AND VICTIM AGE

	Age	Diarrhoea			SD1 Dysentery		
		Mild	Moderate	Severe	Mild	Moderate	Severe
Require formal treatment (% of incidents)	< 5 > 5	10% 0%	70% 50%	100% 100%	70% 50%	100% 100%	100% 100%
Obtain formal treatment (% of requiring)	< 5 > 5	50% 50%	70% 70%	90% 90%	80% 80%	100% 100%	100% 100%
Health practitioner only (# of visits)	< 5 > 5	0.2 -	1 0.5	- -	0.5 0.25	- -	- -
Clinic/Health practitioner (# of visits)	< 5 > 5	0.7 0.1	1 0.5	1.5 1	0.5 0.5	1 0.5	1 1
Hospital out-patient (# of visits)	< 5 > 5	0.3 0	1 0.5	1.5 1	0.5 0	2 1.5	2 2
General ward (d)	< 5 > 5	0 0	2 1	7 3	0 0	6 3	13 8
High care (d)	< 5 > 5	0 0	0 0	0.2 0.04	0 0	0 0	0.4 0.2
Local transport (# of trips)	< 5 > 5	0.7 0.1	1 0.5	1.5 1	0.5 0.5	1 0.5	1 1
Hospital transport (# of trips)	< 5 > 5	0.3 0	1.5 0.5	2.5 2	0.5 0	2.5 2	3 2.5

Total non-productive patient time: represents the effective impact on economic activity, for which the days at each level of impairment are weighted by the percentage of impairment.

Total non-productive care-provider time: represents the total effective time that a care provider is not able to pursue other productive activities, because they are assisting the patient.

Health service impacts

The requirements of diarrhoeal and SD1 incidents in terms of the required treatment and health services are presented in Table 4, based on information and observations of the effect of illness in KwaZulu-Natal hospitals, provided by Drs Rollins, Wittenburg and Robinson (1996). Not all incidents require or obtain formal treatment, and once again differentiation was only made between children less than 5 years old.

Require formal treatment: indicates the percentage of cases in each morbidity severity class which should be treated by a doctor, clinic or hospital.

Obtain formal treatment: represents the percentage of those requiring formal treatment, who receive treatment. People may not receive formal treatment due to the lack of transport money, limited availability of a local health service or personal choice.

Unfortunately, many people in rural settlements may only receive health services when it is too late. This issue has been incorporated into the incidence rates.

The health service impacts have been separated into:

- **Health practitioner only**: indicates the average number of visits a patient requiring formal clinic or hospital treatment, but not obtaining it, would make to their local health practitioner (including doctors, community health workers and traditional healers).
- **Clinic/Health practitioner**: indicates the number of visits a patient requiring formal clinic or hospital treatment would make to their local clinic or health practitioner.
- **Hospital out-patient**: indicates the average number of visits to a hospital out-patient facility.
- **General ward***:* represents the average number of days that a patient requiring formal treatment would spend in a general hospital ward.
- **High care**: represents the number of days that a patient requiring treatment would spend in a high care ward or intensive care unit (ICU).

Local transport: reflects the average number of return trips to local health practitioners or clinics per illness incident, for those requiring formal health services; only 50% of these are assumed to incur costs, while the other 50% were assumed to have walked.

TABLE 5
SUMMARY OF DIARRHOEAL AND SD1 DYSENTERY IMPACTS IN KWAZULU-NATAL AND SOUTH AFRICA

	South Africa	KwaZulu-Natal	
	Diarrhoea	Diarrhoea	SD1
Total number of cases (incidents/yr)	24 000 000	5 400 000	76 000
Require treatment (incidents/yr)	2 800 000	650 000	63 000
Mortality (deaths/year)	43 000	10 000	1 000
Lost productivity (d/yr)			
adult victims and care givers	18 000 000	4 200 000	290 000
school children	3 200 000	700 000	84 000
Health system (#/year)			
health care (visits/year)	4 000 000	900 000	120 000
hospital (d/yr)	4 900 000	1 100 000	230 000

Hospital transport: reflects the number of return trips to a hospital, either by the patient or visitors; only 70% of these are assumed to incur travel costs.

The social and health impacts

The incidence rates and impacts of diarrhoea and SD1 estimated from the preceding information are shown in Table 5. These reflect the rates associated with diarrhoeal disease alone, and do not take account of the impacts of other diseases which are affected by WSS infrastructure (such as typhoid and hepatitis), or the impact of AIDS which often presents as diarrhoea.

Only approximately 12% of all diarrhoeal incidents require some degree of formal treatment from a doctor, clinic or hospital, with the remainder being self-treated. The virulence of SD1 dysentery results in about 80% of all cases requiring formal treatment.

About 70% of diarrhoeal disease incidents occur in children under 5 years old (only about 15% of the population), while about 60% of the diarrhoea incidents are associated with people receiving lower than RDP WSS levels of infrastructure (about one third of the population), which illustrates its selective nature. On the other hand, only 20% of the epidemic SD1 cases are children, because it attacks all age groups, with 80% of the cases in less than RDP WSS households.

This selective characteristic is even more apparent in the mortality incidents, where about 90% of deaths from diarrhoeal disease are under five years. These figures imply that one child dies each year for every 150 under the age of five years in South Africa. For those born into settlements without RDP levels of water supply and sanitation, the average is closer to one in every 65 children under the age of five years, which is consistent with the international experience in developing countries (Esrey et al., 1990).

Deaths from SD1 occur relatively evenly in all age groups. These figures were extrapolated from studies of the dysentery epidemic in northern KwaZulu-Natal during 1995 (CDC, 1996) and represent the consequences of an epidemic, rather than ongoing incidence. SD1 resulted in a similar number of total deaths for schoolchildren (5 to 16 years) and adults (> 16 years) as diarrhoeal disease in KwaZulu-Natal (about 850 deaths per year), despite having a far lower incidence rate (1.5% of the total number of cases). This dramatically illustrates the severity of the SD1 epidemic. This pattern is similar to international trends for SD1 epidemics in developing countries (Bennish and Wojtyniak, 1991; Taylor et al., 1991; Ries, 1996).

The total potential productivity which is lost due to diarrhoea is significant, for both the adult victims and care givers, and is equivalent to about one day per adult per year. However, the age selectivity of diarrhoeal disease results in 80% of this lost productivity being associated with providing care for relatives (largely children) with diarrhoea. The average school absenteeism associated with diarrhoeal disease for children between the ages of 5 and 16 years is about 0.3 d/yr, although on average it is about 5 times higher for those children without adequate WSS infrastructure compared to those with on-site WSS. This has negative impacts on learning and skills development and thus future potential productivity for those who are most affected. Although the overall incidence of SD1 is lower than diarrhoea, the impact on the affected individual is far higher, with about 10 times greater loss in productivity per incident. Furthermore, an equal number of days is lost by adult victims and adult caretakers, because the adult incidence is high.

The people needing formal treatment for more severe diarrhoea require on average 1.5 visits to a health care facility (GP, clinic or hospital) and 2 d stay in the facility. A higher average of 2 visits to a health care facility and an average of 3.5 d in hospital are required for people needing formal treatment for SD1, due to the greater severity of this disease. The estimates of the number of hospital bed-days/yr associated with diarrhoea represent about 8% of the total available bed days in public hospitals (CSS, 1996).

The preceding discussion has outlined some of the quantifiable short-term impacts of diarrhoea and epidemic dysentery. However, there are a number of impacts that cannot be quantified given our current data availability and knowledge. These include:

- The impacts of diarrhoeal disease on nutrition, reduced immunity to other diseases and cognitive skills, particularly in children.

TABLE 6
SOCIO-ECONOMIC DATA (1995) FOR PEOPLE WITH DIFFERENT LEVELS OF WATER SUPPLY AND SANITATION INFRASTRUCTURE IN SOUTH AFRICA

WSS level	Population (thousands)	Adults (thousands)	Households (thousand)	Household income (R/month)	Income per adult (R/d)
< RDP water and sanitation	12 600	6 300	2 200	900	10
> RDP water or sanitation	12 600	6 950	2 500	1 200	15
On-site water and sanitation	16 800	10 950	4 200	3 500	45
Total[1] or weighted average[2]	42 000[1]	24 400[1]	8 900[1]	2 300[2]	28[2]

- The discomfort, pain, suffering, personal anguish and social disruption for the victims and families associated with diarrhoeal illness.
- The long-term impacts of high infant mortality on people's perceptions around population control and dynamics, particularly in the highly affected poorer communities.
- The impacts of other diseases associated with inadequate water supply and sanitation.

Cost information

Estimating the full costs of lost productivity due to illness is difficult, and there are a number of methodological issues that need to be resolved. A simple assumption is that the average income per adult represents the lost income directly to a household, while the average gross domestic product (GDP) per adult indicates their contribution to the economy. Although those most affected by diarrhoeal disease usually have the lowest income (and possibly contribution to the GDP), applying differential incomes has serious consequences in terms of equity.

The average income per household with access to different WSS infrastructure in South Africa is shown in Table 6, with an indication of the associated average daily income per adult, based on information from Eskom (1996) and CSS (1996) data. The total household income in South Africa during 1995 was R230 bn., while the national gross domestic product (GDP) was about R430 bn. This is equivalent to an average daily income of R28/adult, or a GDP of R48/adult·d. The corresponding total annual household wage for KwaZulu-Natal was about R43 bn. with a provincial gross geographic product (GGP) of about R51 bn. This is equivalent to a daily adult income of R27 or a GGP of R29/adult·d. For this screening assessment, a constant R30/d was used for lost productivity by an adult victim, while care providers' lost productivity was assumed to be half as great (R15/d), to reflect the possible flexibility in household choice of a "less-productive" care provider. These are conservative estimates, which is consistent with the approach adopted throughout this study. This low value implicitly takes account of those adults without any income.

Estimation of the cost of health care is more direct and was based on an average cost or charge for non-subsidised patients by health practitioners, clinics and hospitals, together with the average price of medicine or drugs required for treating illness at different levels of severity. The non-subsidised cost was assumed to represent the real total cost of the health service borne by the government (in the case of subsidised health), plus any additional cost borne by the individual. Average estimates of these total costs are indicated in Table 7, and were based on a synthesis of figures obtained from University of Natal records from King Edward Hospital and other economic costing studies (Van Horen, 1996). Although the governmental budget allocation to these health services is unlikely to be reduced if diarrhoeal disease is controlled, this would allow the service to be redirected to other pressing health needs which may not be fully addressed at present, and so can be interpreted as opportunity costs. The portion of the total borne by public health was not estimated.

Estimation of the average cost of **adult patient lost productivity** and **care giver lost productivity** was presented above (based on Table 6).

The costs presented for health care are based on the real cost, whether paid by the patient or subsidised by the government, and were based on the average price of public health services.

- **Health practitioners and clinics**: include clinic staff, doctors, community health workers and traditional healers and represents a total average cost to government and the individual for that service.
- **Out-patients**: costs include the basic cost of a visit, as well as any additional tests that would be required in more severe cases, representing the total average cost to government and the individual.
- **General ward** and **high care**: costs include the cost of all support required for that hospital bed, as well as any general supplies required.

Medicine: costs represent the average price of drugs and supplies required to treat an episode of diarrhoea or SD1 dysentery, either under health care or self-treatment.

Transport: costs represent the average cost of a return trip to either a local health practitioner/clinic or a hospital, for those people who incur costs through using private or public transport. These costs were assumed to have been incurred for 50% of local trips to a health practitioner or clinic and 70% of hospital cases, with the remainder walking to health services and thus not incurring direct public or private transport costs.

The total costs

Estimates of the costs associated with the short-term impacts on lost productivity, direct health-care costs and transport associated with health care are presented in Table 8, representing the combination of information presented in Tables 5 and 7.

Table 8 indicates that the direct health costs of diarrhoea have the most significant impact, accounting for about 90% of the total estimated cost. This cost is borne by both the government and private individuals, and represents about 20% of the respective provincial and national health budgets. The socio-economic

TABLE 7
PRODUCTIVITY, HEALTH SERVICE AND TRANSPORT COSTS AT DIFFERENT LEVELS OF MORBIDITY SEVERITY

	Mild	Moderate	Severe
Adult patient lost productivity	R30/d	R30/d	R30/d
Care giver lost productivity	R15/d	R15/d	R15/d
Health practitioner and clinic	R20/visit	R20/visit	R20/visit
Hospital out-patient	R90/visit	R180/visit	R270/visit
General ward (clinic or hospital)	R375/d	R375/d	R375/d
High care (or ICU)	R1200/d	R1200/d	R1200/d
Diarrhoea medicine: health care self-treatment	R10/incident R10/incident	R50/incident R20/incident	R400/incident R40/incident
SD1 medicine: health care self-treatment	R30/incident R20/incident	R75/incident R40/incident	R400/incident R50/incident
Local transport (return trip)	R8/trip	R8/trip	R8/trip
Hospital transport (return trip)	R20/trip	R20/trip	R20/trip

TABLE 8
SUMMARY OF DIARRHOEAL AND SD1 DYSENTERY COSTS IN KWAZULU-NATAL AND SOUTH AFRICA

	South Africa	Kwazulu-Natal	
	Diarrhoea	Diarrhoea	SD1 Dysentery
Productivity cost (R m./yr)	325	75	6
Health costs (R m./yr)	3 000	700	112
Transport costs (R m./yr)	40	8	2
Total costs (R m./yr) Average household cost (R/yr)	3 375 380	785 430	120 67

profile of the affected population implies that a large portion (possibly 40% to 60%) of this cost may be borne by the public health service (about 10% of the total budgets). The greatest portion of health costs (up to 60%) is associated with treatment in hospital (i.e. hospital beds), which is also one of the most limited resources in the health services. The estimates presented in this analysis indicate that about 8% of the bed-days available in public hospitals may be associated with diarrhoeal disease. The relative inexpensiveness of drugs and medicines for diarrhoea, results in these accounting for only about 15% of the diarrhoea health care costs and 7.5% of the SD1 health care costs. However, observed antimicrobial resistance patterns of SD1 to nalidixic acid, may necessitate a change in the antibiotic regime required, resulting in a fourfold increase in drug costs.

The cost of lost productivity is about 10%, while transport costs account for about 1%, of the total costs of diarrhoeal disease. These estimated costs are borne by the household or employer of the victim. On the one hand they may be higher than the actual real costs, because an average for all South Africans was assumed; the real productivity costs may only be half as much, when the average is weighted by the lower incomes of the most affected groups. However, each South African makes a contribution to the GDP, while the real contribution of the more marginalised groups may be underestimated, particularly in the rural informal and subsistence economy. The high dependency ratios in some rural areas (i.e. one adult wage earner supporting up to 15 other people) also highlights the potential severity of lost productivity due to illness.

When all these factors are included, the estimates are deemed to be acceptable indicators of the short-term costs. However, these do not take account of a number of other costs, including:

- The costs of secondary "ripple" effects of lost productivity throughout the economy.
- The real cost of personal anguish and social disruption associated with illness and death from diarrhoea.
- The long-term costs of lost potential productivity and chronic symptoms associated with diarrhoea, such as reduced nutritional status, disease immunity and cognitive ability.
- The long-term welfare cost of higher population growth rates in disadvantaged communities, due to perceptions about child mortality partially associated with diarrhoeal disease.
- The opportunity cost of growth to the economy associated with allocating national and personal resources to "non-productive" activities addressing the health problems associated with diarrhoea.

Although quantification of these costs is not attempted for this analysis, the total actual costs of diarrhoeal disease may be higher than these estimates. International empirical studies have shown that the perceived cost of illness (WTP) may be as much as 2.4 times the direct cost of illness (Rowe et al.,1994), depending upon the type of impact.

A recent study by the DWAF (1996) has indicated that the number of people without WSS infrastructure may also be higher than the estimates used in this study. If these estimates are used, the number of deaths in KwaZulu-Natal and South Africa are about 25% and 15% higher, respectively, and the total cost estimates are about 18% and 10% higher, respectively. On the other hand, the preliminary 1996 census results indicate that the total South African population is about 10% lower than the values used in this study, which would scale down these estimates.

Whatever the total costs, the preceding analysis indicates that up to 15% of the South African health budget may be spent on addressing diarrhoeal disease. Furthermore, the total costs of diarrhoea are equivalent to at least 1% of the South African GDP.

Potential benefits of water supply and sanitation

This analysis was not aimed at estimating the benefits of interventions in water supply and sanitation infrastructure or health services. However, a preliminary estimate indicates that the national provision of RDP levels of water supply and sanitation may significantly reduce the incidence, severity, mortality and costs of diarrhoeal disease. This assumes that other factors causing high levels of diarrhoeal disease in poorer settlements are addressed simultaneously, particularly hygiene education, health care and child nutrition.

International studies (Esrey et al., 1990) indicate that water and sanitation interventions in other developing countries, have produced median reductions in diarrhoeal morbidity of 25% (ranging from 0% to 100%) and mortality of 65% (ranging from 43% to 79%). However, what is most important is that the severity of the illness is reduced far more than the incidence, which is reflected by the greater reduction in mortality. This has significant impacts on the costs of illness, as less severe cases incur far lower health and social costs.

Conclusions

The rapid screening assessment described in this report has indicated that:

- A substantial number of South Africans die every year from diarrhoeal disease (about 43 000).
- On average, one in every 14 South Africans requires formal treatment for diarrhoea every year.
- The annual public and private direct health care costs incurred due to diarrhoea are at least R3.0 bn.
- The total social cost of diarrhoeal disease is at least 1% of the GDP in South Africa (R3.4 bn.).

Despite affecting only about 1% as many people as diarrhoea, the current SD1 epidemic in KwaZulu-Natal has resulted in a disproportionately high number of deaths and costs (i.e. about 10% of the total caused by diarrhoea). In 1996/97 the SD1 epidemic reappeared throughout KwaZulu-Natal and moved southwards into the Eastern and Western Cape and northwards into Mpumalanga. These provinces have similar demographic and socio-economic profiles to KwaZulu-Natal. Therefore, the health and cost estimates derived in this analysis are likely to continue and probably increase unless effective measures are taken to halt the epidemic.

Recommendations

Interventions in water supply and sanitation infrastructure, in line with the RDP Community Water Supply and Sanitation programme, together with hygiene education and the extension of primary health care services in South Africa, need to be implemented within an integrated multidisciplinary framework (GNU, 1995). This should result in a significant reduction in the incidence of diarrhoeal disease and its severity (including death), which may be associated with a reallocation of health care resources to other pressing health and social needs. Furthermore, other social and health benefits from improved services probably outweigh the purely diarrhoeal related benefits estimated in this analysis.

This study only provides a preliminary indication of the possible health impacts and costs associated with diarrhoeal disease, and is highly dependent upon the accuracy of the estimated incidence rates. Further study and research are required if these estimates are to be made more accurate and reliable, and the causal relationships governing the incidence and severity of diarrhoeal disease in South Africa are to be better understood. These investigations are of particular importance, because information of the type presented in this document is required to guide political decisions about allocation of funds to infrastructure, health and education.

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References

BENNISH ML and WOJTYNIAK BJ (1991) Mortality due to Shigellosis: Community and hospital data. *Reviews of Infectious Diseases* **13** (4) S245-S251.

CENTRES FOR DISEASE CONTROL(CDC) (1996) *Memorandum of EPI-AID Trip Report: Epidemic Dysentery in South Africa.* No 96-26. Food and Diarrhoeal Diseases Branch.

CSS (1996) *RSA Statistics in Brief.* Central Statistical Services, Pretoria. Republic of South Africa.

DWAF (1996) *Community Water Supply and Sanitation: Strategic Study - National Assessment*. Pretoria.

DWAF (1995) *Water Supply and Sanitation White Paper*. DWAF, Pretoria

ESKOM (1996) *SA to Z: An Aid to Decision Making in South Africa*, Pretoria.

ESREY SA and HABICHT J-P (1986) Epidemiological evidence for health benefits from improved water and sanitation in developing countries. *Epidemiol. Rev.* **8** 117-128

ESREY SA, POTASH J, ROBERTS L and SHIFF C (1990) Health Benefits from Improvements in Water Supply and Sanitation: Survey and Analysis of the Literature on Selected Diseases. WASH Report No 66.

FEACHEM RG, BURNS E and CAIRNCROSS S (1978) *Water, Health and Development*. London. Tri-Med Books.

GNU (1995) *National Sanitation Policy: Draft White Paper on Sanitation*. National Sanitation Task Team.

LISTORTI JA (1990) *Environmental Health Components for Water Supply, Sanitation and Urban Projects*. World Bank Technical Paper No 121. Washington, DC.

PAUL JE and MAUSKOPF JA (1991) *Cost-of-Illness Methodologies for Water-related Diseases in Developing Countries.* WASH Technical Report No 75. Arlington, Va.

PAYMENT P, RICHARDSON L, SIEMIATYCHI J, DEWAR R, EDWARDES M and FRANCO E (1991) A randomised trial to evaluate the risk of gastrointestinal disease due to consumption of drinking water meeting current microbiological standards. *Am. J. Public Health* **81** (6) 703-708.

RIES A (1996) *Shigella Dysenteriae* Type 1: An African perspective. *Proc. of the Epidemic Dysentery Seminar*. Fern Hill (Howick), 7 November 1996. Epidemic Dysentery Task Team. Umgeni Water.

ROBINSON AKL (1992) *Health Aspects of Sanitation in the Mafakatini Region of Rural Vulindlela Natal/KwaZulu*. Durban Health.

ROBINSON AKL (1993) Results of clinic and hospital surveys for diarrhoeal diseases in children in KwaZulu-Natal. Durban Health.

ROBINSON AKL (1996) Personal communication. Chief Medical Health Officer, City of Durban, South Africa.

ROLLINS N (1996) *Shigella dysenteriae* Type 1 in KwaZulu-Natal. *Proc. of the Epidemic Dysentery Seminar*. Fern Hill (Howick), 7 November 1996. Epidemic Dysentery Task Team. Umgeni Water.

ROWE R, LANG C, BIRD L, CALLAWAY M, CHESTNUT L, ELDRIDGE M, LATIMER D, LIPTON J and RAE D (1994) *New York State Environmental Externalities Cost Study*. RCG/Hagler, Bailly, Inc. Empire State Electric Energy Research Corporation, Albany.

TAYLOR DN, BODHIDATTA L and ECHEVERRIA P (1991) Epidemiological aspects of Shigellosis and other causes of dysentery in Thailand. *Rev. of Infectious Diseases* **13** (4) S266-S230.

TONGLET R, ISU K, NPESE M, DRAMAIX M and HENNART P (1992) Can improvements in water supply reduce childhood diarrhoea. *Health, Policy and Planning* **7** (3) 260-268.

VAN HOREN C (1996) Counting the Social Costs: Electricity and Externalities in South Africa. Industrial Strategy Project Report, Elan & UCT Press, Cape Town.

VICTORIA CG, SMITH PG, VAUGHAN JP, NOBRE LC, LOMBARDI C, TEIXEIRA AMB, FUCHS SC, MOREIRA LB, GIGANTE LP and BARROS FC (1988) Water supply, sanitation and housing in relation to the risk of infant mortality from diarrhoea. *Int. J. Epidemiol*. **17** (3) 651-654.

VON SCHIRNDING Y, YACH D and MATTHEE A (1993) Health aspects of sanitation, with special reference to South Africa. *CHASA J.* **4** (3&4) 73-79.

WITTENBURG D (1996) Paediatric diarrhoea - Focus on a national Health problem. *Proc. of the Epidemic Dysentery Seminar*, Fern Hill (Howick), 7 November 1996. Epidemic Dysentery Task Team. Umgeni Water.

WITTENBURG D (1996) Personal communication.p Professor of Paediatrics, University of Pretoria, RSA.

WIBOWO D and TISDELL C (1993) Health, safe water and sanitation: A cross-sectional health production function for Central Java, Indonesia. *Bull. of the World Health Organisation* **71** (2) 237-245.