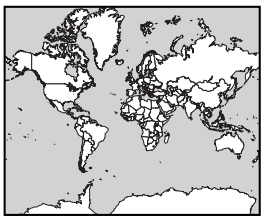

Water, sanitation and urban children: the need to go beyond "improved" provision

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SUMMARY: This paper reviews the implications of inadequate provision of water and sanitation for children's health and general development, especially in urban areas. Research into health differentials shows that child mortality and morbidity rates in poor urban settlements can equal or exceed those in rural areas. This review considers, in particular, the higher vulnerability of children to sanitation-related illness, the links between unsanitary conditions and malnutrition, the impacts for mental and social development, and the practical day-to-day realities of poor provision for children and their caregivers in urban areas. It argues that health education and health care, while essential complements to proper provision, can in no way be considered alternative solutions. The true costs for children of a failure to respond to this ongoing emergency lend another dimension to discussions of the cost-effectiveness of various solutions.

I. INTRODUCTION

IN POOR URBAN communities around the world, thousands of children still die every day from preventable diseases related to the inadequate provision of water and sanitation. Many more live with repeated diarrhoea, worm infestations, skin infections and chronically challenged immune systems as a result of their unsanitary surroundings. The effects can be long term, and may include both physical and mental stunting. But solutions will continue to be less than satisfactory if they fail to address the particular ways in which children are affected by this problem.

This paper reviews current knowledge of the implications of inadequate provision for children's health and general development, and looks at the practical realities for children and their caregivers in urban areas. It argues that health education and health care, while essential complements, can in no way be considered alternatives to provision. Concerns about cost-effectiveness take on a different dimension if consideration is given to the true costs for children of failing to respond to this ongoing emergency.

II. AN OVERVIEW OF THE SITUATION

ALTHOUGH INSUFFICIENT AND unsafe water supplies and sanitation affect people of all ages, the well-being of young children is

particularly compromised. Approximately 84 per cent of the global burden of diarrhoeal disease (still a major cause of death and illness in all age groups) affects children aged under five; 74 per cent of the burden from helminth (worm) infections affects children aged between five and fourteen.(1)

Around half of the world's children (approximately one billion) now live in urban areas, the great majority of them in cities and towns in Africa, Asia and Latin America.(2) In many communities, children form over 50 per cent of the population – not, in other words, a special interest group. Urban children have long been considered better off in terms of health and survival, but this urban advantage has declined in some areas and is increasingly being called into question.(3) Those living in poor urban settlements face some of the most difficult environmental conditions, and investigations into health differentials show that child mortality and morbidity rates in these settlements equal or exceed those in rural areas. Research from five communities in the Republic of Congo, for example, found the prevalence of diarrhoea was 3.5 times greater for urban than for rural children – and that the rural–urban variable was more significant than socioeconomic, demographic or behavioural factors.(4) Studies comparing rural and urban areas in Egypt, Zimbabwe and Malawi have also found a higher prevalence of intestinal parasites and worms among urban children.(5) High concentrations of people and wastes in urban areas create more opportunities for exposure to pathogens, and a correspondingly greater need for the levels of hygiene that adequate water and sanitation make possible.

There are considerable variations between and within cities. In cities well served by piped water, sanitation, drainage, waste removal and good health care, child mortality rates are generally around 10 per 1,000 live births, and few child deaths result from water-related diseases. In cities or neighbourhoods with inadequate provision, mortality rates are commonly 10 to 20 times higher. In a well-managed city, there is little difference in mortality rates for low- and high-income areas; in a badly managed city, they can vary by a factor of 10, 20 or more. Surveys in seven settlements in Karachi found that infant mortality rates varied from 33 to 209 per 1,000 live births.(6) In some informal settlements in Nairobi, where around half the city's population lives, under-five mortality rates were more than double the average for Nairobi (Table 1), as well as significantly higher than the Kenyan rural average.(7)

There are differences of opinion regarding the actual contribution of water and sanitation provision to levels of child death and disease. Child mortality rates are generally more highly correlated with a lack of access to potable water and sewerage connections than with other commonly cited variables such as the number of households below the poverty line or the availability of health services;(8) and some studies have established tight links between health and environment even when socioeconomic variables are held constant.(9) But the influence of water and sanitation is related in complex ways to these other factors, and the relationship can vary from place to place. An analysis of demographic and health data from Ghana, Egypt, Brazil and Thailand shows that the relative importance of socioeconomic status, access to health services and levels of provision varies from country to country. In Ghana, envi-

1. WHO (1999), *World Health Report, 1999 Data Base*, World Health Organization, Geneva; also Murray, C J and A D Lopez (1996), *The Global Burden of Disease: A Comprehensive Assessment of Mortality and Disability from Diseases, Injuries and Risk Factors in 1990 and Projected to 2020*, Harvard University Press, Boston.

2. UNICEF (2002), "*Poverty and Exclusion among Urban Children*", Innocenti Centre, Florence, Italy.

3. For instance, the infant survival advantage in big cities in Latin America and the Caribbean was found to have disappeared by the early 1990s – see Brockerhoff, M and E Brennan (1998), "The poverty of cities in developing regions", *Population and Development Review* Vol 24, No 1, pages 75–114. Analysis by Mark Montgomery (Population Council) in 2002 of 86 demographic and health surveys held in 53 different nations between 1986 and 1998 has also shown increasing under-five mortality rates in urban areas in some countries – for instance, in Madagascar when comparing 1992 and 1997, in Mali when comparing 1987 and 1995, in Zambia when comparing 1992 and 1996, and in Zimbabwe when comparing 1988 and 1992.

4. Mock, Nancy B, Thomas A Sellars, Ahmed A Abdoh and Robert Franklin (1993), "Socioeconomic, environmental, demographic and behavioural factors associated with the occurrence of diarrhoea in young children in the Republic of Congo", *Social Science and Medicine* Vol 36, No 6, pages 807–816.

5. Mason, P R, B A Patterson and R Loewenson (1986), "Piped water and intestinal parasitism in Zimbabwean schoolchildren", *Transactions of the Royal Society of Tropical Medicine and Hygiene* Vol 80, No 1, pages 88–93; also Curtale, F, M Y Shamy, A Zaki, M Abdel-Fattah and G Rocchi (1998), "Different patterns of intestinal helminth infection among young workers in urban and rural areas of Alexandria governorate, Egypt", *Parasitologia* Vol 40, No 3, pages 251–254; and Phiri, K, C J Whitty, S M Graham and G Sembatya-Lule (2000), "Urban/rural differences in prevalence and risk factors for intestinal helminth infection in southern Malawi", *Annals of Tropical Medicine and Parasitology* Vol 94, No 4, pages 381–387.

6. Surveys undertaken by the Community Health Department of the Aga Khan University, quoted in Hasan, Arif (1999), *Understanding Karachi: Planning and Reform for the Future,* City Press, Karachi, 171 pages.

7. APHRC (2002), "Population and health dynamics in Nairobi's informal settlements", African Population and Health Research Centre, Nairobi, Kenya, 256 pages.

8. Shi, A (2000), "How access to urban potable water and sewerage connections affects child mortality", Development Research Group, World Bank, Washington DC.

9. For instance, Victoria, C G et al. (1988), "Water supply, sanitation and housing in relation to the risk of infant mortality from diarrhoea", *International Journal of Epidemiology* Vol 17, No 3, pages 651–654; also Woldemicael, G (2000) "The effects of water supply and sanitation on childhood mortality in urban Eritrea", *Journal of Biosocial Science* Vol 32, No 2, pages 207–227.

10. Timaeus, I M and L Lush (1995), "Intra-urban differentials in child health", *Health Transition Review* Vol 5, pages 163–190.

11. Official figures vary. Global Burden of Disease figures for 2000 show 1.3 million annual deaths from diarrhoeal disease for children under the age of five – see Murray, C J, A D Lopez, C D Mathers and C Stein (2001) "The Global Burden of Disease 2000 project: aims, methods and data sources", Global Programme on Evidence for Health Policy Discussion Paper No 36, World Health Organization. The WHO 1999 figures indicate 1.85 million deaths from diarrhoeal disease for children under the age of five and another 0.13 million for children aged 5–14. In addition, there are the deaths related to parasites and to malnutrition. In 1990, there were an estimated 3 million deaths annually from diarrhoeal disease for children under the age of five.

Table 1: Mortality and morbidity rates for infants and young children in the informal settlements of Nairobi

Location	Infant mortality (per 1000)	Under-five mortality rate (per 1000)	Prevalence of diarrhoea* (per cent)	Prevalence of diarrhoea with blood* (per cent)
Nairobi informal settlements (average)	91.3	150.6	30.8	11.3
Central	68.0	123.1	34.6	13.6
Makadara	86.3	142.7	20.4	40.0
Kasarani	77.4	124.5	30.8	9.2
Embakasi	163.6	254.1	27.6	9.1
Pumwani	72.6	134.6	26.7	12.5
Westlands	103.0	195.4	30.4	12.2
Dagoretti	35.0	100.3	26.0	10.5
Kibera	106.2	186.5	36.9	9.8
National**	73.7	111.5	17.1	3.0
Rural**	75.9	113.0	17.1	3.1
Nairobi**	38.7	61.5	12.9	3.4
Other urban**	56.6	83.9	19.4	1.7

SOURCE: APHRC (2002), "Population and health dynamics in Nairobi's informal settlements", African Population and Health Research Centre, April, 256 pages.
* Percentage of children under the age of three with watery diarrhoea or diarrhoea with blood during the two weeks preceding the survey.
** Based on the 1998 Kenya Demographic and Health Survey.

ronmental differentials in the prevalence of diarrhoea are modest after socioeconomic status is controlled for – probably a reflection of the fact that provision is poor throughout urban areas and falls below the threshold at which exposure to infection begins to decline; income-related factors are more significant here in the relative effects they have on children. In Thailand, inequalities in environmental conditions are strongly correlated with the prevalence of diarrhoea but not with mortality – probably because of widespread access to health services.[10] Regardless of differences from place to place, however, it is clear that children's right to health and survival depends to a critical extent on safe, healthy environments.

III. THE HEALTH BURDEN FOR CHILDREN

ALTHOUGH SIGNIFICANT PROGRESS has been made in recent decades, between 1 and 2 million children still die each year from diseases directly related to water and sanitation.[11] These diseases, especially combined with undernutrition, can so weaken the body's defences that they contribute to other causes of death as well, such as measles and pneumonia.[12] Hundreds of millions more children,

because of poor provision, are debilitated by illness, pain and discomfort, primarily from diarrhoeal diseases but also from other waterborne diseases such as cholera and enteric fevers, from schistosomiasis and guinea worm, from heavy intestinal worm burdens, and from various skin and eye diseases and infections such as scabies and trachoma.[13] In the poorest countries and neighbourhoods, unsanitary living conditions probably account for at least half of the total burden of ill heath.[14] The water and sanitation-related health burden for children under the age of five in Africa, for instance, is up to 240 times higher than it is in high-income nations.[15]

a. Children's higher vulnerability to pathogens

Children's vulnerability to pathogens is related both to their exposure and to their level of immunity. Small children have a drive to play and explore, they are in close contact with the ground and they have little appreciation of hygiene; they are more likely to come into contact with excreta, the primary source of diarrhoeal disease and intestinal parasites, as well as other pathogens. Before they are mobile, infants are relatively protected from exposure to pathogens, especially those being breastfed. But because their immune systems are not well developed, they are still highly susceptible.[16] Bottle-fed infants are at especially high risk. Without clean water and hygienic conditions, bottles cannot be sterilized and formula cannot be mixed safely. A survey of the milk fed to 149 6–24-month-olds in a slum settlement in Varanasi, India, found that 53 per cent of the samples were contaminated by bacteria. The odds of contamination were 25 times higher when feeding utensils were not properly cleaned.[17] Although HIV-positive mothers are warned about the possibility of transmitting the virus to their infants through breastfeeding, the reality is that many of these infants, if bottle-fed in environments that do not support adequate hygiene, are at even higher risk of death from diarrhoeal disease than from AIDS.[18] Children being weaned from the breast are also at high risk, as they first encounter the pathogens in a contaminated environment. A prospective study in the Philippines found that even small amounts of contaminated water nearly doubled the risk of diarrhoea for breastfed infants.[19]

Children in child care centres and other institutions may also be more vulnerable to diarrhoea, as demonstrated in several studies from urban areas in Latin America.[20] Possibilities for disease transmission are always higher when a number of children are together, and inadequate toilets or hand-washing facilities may allow parasites or disease to spread quickly from child to child and from there through the community.

b. The links between unsanitary conditions and malnutrition

Diarrhoea and intestinal parasites, along with the poor water and sanitation provision that promotes them, have complex and reciprocal links to malnutrition in children.[21] Malnutrition weakens the body's defences and makes children more vulnerable to disease. At the same time, diarrhoea and intestinal parasites contribute to

12. WHO (1992), *Our Planet, our Health: Report of the WHO Commission on Health and Environment*, World Health Organization, Geneva.

13. Bradley, D, C Stephens, S Cairncross and T Harpham (1991), "A review of environmental health impacts in developing country cities", Urban Management Programme Discussion Paper No 6, the World Bank, UNDP and UNCHS (Habitat), Washington DC; also see reference 5, Curtale et al. (1998); Ludwig, K, F Frei, F Alvares-Filho and J T Ribeiro-Paes (1999), "Correlation between sanitation conditions and intestinal parasitosis in the population of Assis, state of Sao Paulo", *Revista da Sociedade Brasileira de Medicina Tropical* Vol 32, No 5, pages 547–555; and Mahfouz, A A, H El-Morshedy, A Farghaly and A Khalil (1997), "Ecological determinants of intestinal parasitic infections among pre-school children in an urban squatter settlement of Egypt", *Journal of Tropical Pediatrics* Vol 43, No 6, pages 341–344.

14. Satterthwaite, D, R Hart, C Levy, D Mitlin et al. (1996), *The Environment for Children*, Earthscan, London.

15. Prüss, Annette, David Kay, Lorna Fewtrell and Jamie Bartram (2002), "Estimating the burden of disease from water, sanitation and hygiene at a global level", *Environmental Health Perspectives* Vol 110, No 5, pages 537–542.

16. Agha, S (2000), "The determinants of infant mortality in Pakistan", *Social Science and Medicine* Vol 51, pages 199–208; also Al-Eissa, Y A, S A Assuhaimi, A M A Abdullah, A M Abobakr and MA Al-Husain et al. (1995), "Prevalence of intestinal parasites in Saudi children: a community-based study", *Journal of Tropical Pediatrics* Vol 41, pages 47–49; and see reference 9, Woldemicael (2000).

17. Ray, G, G Nath and D C Reddy (2000), "Extents of contamination of top milk and their determinants in an urban slum of Varanasi, India", *Indian Journal of Public Health* Vol 44, No 4, pages 111–117.

18. UNICEF (1998), *The State of the World's Children 1998*, Oxford University Press, New York.

19. VanDerslice, J, B Popkin and J Briscoe (1994), "Drinking water quality, sanitation and breastfeeding: their interactive effects on infant

malnutrition by causing decreased food intake, impaired nutrient absorption and direct nutrient losses.[22] Even a relatively mild infestation of parasites can consume 10 per cent of a child's total energy intake as well as interfering with digestion and absorption.[23] Unsanitary environments also contribute to malnutrition by challenging children's immune systems; nutrients that would otherwise support growth go instead towards supporting the immune response.[24] Data from 84 countries indicate that the best predictor of nutritional status, next to sufficient funds for food, is the level of access to water.[25] The case is often made that the effects of diarrhoea on growth are transient and that children generally catch up quickly. This appears to be true if they have stretches of diarrhoea-free time[26] but, for many children, diarrhoea in the early years may be too severe or too frequent to allow for catch-up growth, and it is associated with continued underweight or substantial shortfalls in growth when children are older.[27] Poor provision can affect growth in other ways too; when water is at a distance, this can contribute to heavy workloads for older children, causing them to burn calories they depend on for adequate nutrition. Carrying overly heavy containers can even contribute to deformities in bone growth.[28]

IV. THE IMPACTS FOR MENTAL AND SOCIAL DEVELOPMENT

RESEARCH IN URBAN Brazil and Peru has demonstrated strong connections between diarrhoeal infections in the first two years of life and cognitive functioning when children are between six and nine. One study controlled for current nutritional status, another for socioeconomic status and amount of schooling children had received.[29] In numerous studies, malnutrition and stunting have been found to be related to children's mental and social development, in both the short and longer terms. Children who have suffered from early malnutrition have lower IQ and school achievement levels and more behavioural problems later on.[30] Some of these studies have observed these effects independent of schooling or socioeconomic status; others have pointed to the fact that stunted children tend to receive less schooling than non-stunted children.[31] Parasitic infestations continue to take their toll on children in school, in part as a result of the cognitive effects of anaemia associated with worms. A study in Java, for instance, found that hookworms had a significant adverse effect on children's working memory, with consequences for their reasoning ability and reading comprehension. This association increased with age.[32]

The effects of malnutrition on children's capacity to learn are not well understood, but it is hypothesized that because stunted children are more listless and slower to develop and move around, they interact less with their social and physical environments and experience lower levels of the stimulation that promotes cognitive development.[33] Some research has found higher levels of physiological arousal in stunted children, along with more inhibition, anxiety and inattention than in non-stunted children from the same poor neighbourhoods. It is hypothesized that higher cortisol levels in these children may be linked to both poor cognitive perform-

health", *Bulletin of the World Health Organization* Vol 72, No 4, pages 589–601.

20. Barros, A J, D A Ross, W V Fonseca, L A Williams and D C Moreira-Filho (1999), "Preventing acute respiratory infections and diarrhoea in child care centres" *Acta Paediatrica* Vol 88, No 10, pages 1113–1118; also Hillis, S D, C M Miranda et al. (1992), "Day care centre attendance and diarrhoeal morbidity in Colombia", *Pediatrics* Vol 90, No 4, pages 582–588; and Sempertegui, F, B Estrella et al. (1995), "Risk of diarrhoeal disease in Ecuadorian day care centres", *Pediatric Infectious Disease Journal* Vol 14, No 7, pages 606–612.

21. Rice, A L, L Sacco, A Hyder and R E Black (2000), "Malnutrition as an underlying cause of childhood deaths associated with infectious diseases in developing countries", *Bulletin of the World Health Organization* Vol 78, No 10, pages 1207–1221.

22. Stephenson, C B (1999), "Burden of infection on growth failure", *Journal of Nutrition* Vol 129 (2S Supplement), pages 534S–538S.

23. See reference 14.

24. Solomon, N W, M Mazariegos, K H Brown and K Klasing (1993), "The underprivileged developing country child: environmental contamination and growth failure revisited", *Nutrition Reviews* Vol 51, No 11, pages 327–332.

25. Lechtig, A and B Doyle (1996), "The impact of water and sanitation on malnutrition and under-five mortality rates", *Waterfront* Vol 8, pages 5–19.

26. Wierzba, T, R El-Yazeed, S J Savarino, A S Mourad et al. (2001), "The interrelationship of malnutrition and diarrhoea in a peri-urban area outside Alexandria, Egypt", *Journal of Pediatrics, Gastroenterology and Nutrition* Vol 32, No 2, pages 189–196.

27. Molbak, K, M Andersen et al. (1997), "Cryptosporidium infection in infancy as a cause of malnutrition: a community study from Guinea-Bissau, West Africa", *American Journal of Clinical Nutrition* Vol 65, No 1, pages 149–152; also Moore, S R, A A Lima, M R Conoway, J B Schorling et al. (2001), "Early childhood diarrhoea and helminthiases associated with long-

ance and decreased functional immunity.[34]

No research that I am aware of has established a direct relationship between access to water and sanitation and children's cognitive functioning. Any number of variables and complications would presumably mediate and confound such a connection. However, given the intermediate links that have been established between provision and disease, disease and malnutrition, and malnutrition and psychosocial performance, for practical purposes it makes sense to acknowledge the possibility and even the likelihood of such a relationship.

The quality of provision may also be related to children's psychosocial development through the direct impact that these services (or their absence) have on opportunities for play and learning. Healthy children are driven by curiosity, energy and a desire for competence to explore the world around them. Through their engagement with their surroundings, they gain important information about the properties of objects, about cause and effect and about their own capacity to make things happen. Through active play, they learn to use their bodies and to understand physical laws and spatial relationships. Through the diversity and repetition of activities, they gain a range of skills and a growing sense of competence and assurance. A stimulating physical environment is a basic support for active learning and has been recognized by many major theorists as fundamental to development.[35] A contaminated environment is not necessarily less stimulating but it can require caregivers to make difficult choices between protecting their children's health and allowing them free access to play.

Poor provision can limit opportunities for older children too, in part by limiting the availability of open space for recreation but also through the impacts on their time. Many children, most often girls, spend long hours each day collecting water, and this can interfere with free time and with school attendance.[36] Girls' attendance can also be affected by the quality of sanitation facilities in school, especially once they have started to menstruate.[37] Many schools, in both urban and rural areas, have inadequate and poorly maintained facilities and, in some cases, none at all.[38] Even where facilities are technically present, they may not be available to children. A recent survey of 70 schools in Bangladesh found that although all schools had at least one toilet, in only 29 schools were these available to children and in only 2 schools was there a separate toilet for girls. The toilets in these schools served between 200 and 500 children each.[39]

V. WHAT LEVEL OF PROVISION DO CHILDREN NEED?

POOR PROVISION VIOLATES children's rights – not only to survival and health but also to optimal development and a decent standard of living.[40] But what should reasonably be considered adequate provision? Recent assessments indicate that over three-quarters of the world's population have access to safe water and over half to proper sanitation. In urban areas, these figures rise to over 90 per cent and 80 per cent, respectively. This looks impressive;

term linear growth faltering", *International Journal of Epidemiology* Vol 30, No 6, pages 1457–1464.

28. See reference 25; also Nicol, A (1998), *Carrying the Can: Children and their Water Environments*, Save the Children–UK, London.

29. Guerrant, D I, S R Moore, A A Lima, P D Patrick, J B Schorling and R L Guerrant (1999), "Association of early childhood diarrhoea and cryptosporidiosis with impaired physical fitness and cognitive function four–seven years later in a poor urban community in northeast Brazil", *American Journal of Tropical Medicine and Hygiene* Vol 61, No 5, pages 707–713; also Berkman, D S, A G Lescano, R H Gilman, S L Lopez and M M Black (2002), "Effects of stunting, diarrhoeal disease and parasitic infection during infancy on cognition in late childhood: a follow-up study", *Lancet* Vol 359 (9306), pages 564–571.

30. Grantham-McGregor, S M (1995), "A review of studies of the effect of severe malnutrition on mental development", *The Journal of Nutrition* Vol 125, No 8 (Supplement), pages 2233S–2238S; also Grantham-McGregor, S M and L C Fernald (1997), "Nutritional deficiencies and subsequent effects on mental and behavioural development in children", *Southeast Asian Journal of Tropical Medicine and Public Health* Vol 28 (supplement 2), pages 50–68; and Mendez, M A and L S Adair (1999), "Severity and timing of stunting in the first two years of life affect performance on cognitive tests in late childhood", *The Journal of Nutrition* Vol 129, No 88, pages 1555–1562.

31. Brown, J and E Pollitt (1996), "Malnutrition, poverty and intellectual development", *Scientific American* Vol 274, No 2, pages 38–43; also see reference 30, Mendez and Adair (1999).

32. Sakti, H, C Nokes, W S Hertanto, S Hendratno et al. (1999), "Evidence for an association between hookworm infection and cognitive function in Indonesian school children", *Tropical Medicine & International Health* Vol 4, No 5, pages 322–334.

33. Engle, P (1996), "Combating malnutrition in the developing world", in Carr, S C and J F Schumaker (editors), *Psychology and the Developing World*, Praeger,

however, it does not mean that all these people are supplied in ways that ensure children's well-being or that take into account the realities of life for those who care for young children.

Current standards, as defined by the World Health Organization and UNICEF,[41] describe reasonable access to an "improved" water supply as the availability of at least 20 litres per person, per day, from a safe source no more than one kilometre from the dwelling.[42] Piped systems are considered acceptable if they operate at 50 per cent of capacity; hand pumps if they operate for 70 per cent of the time. For sanitation, "improved" provision includes connections to a public sewer or a septic system; also pour-flush latrines, ventilated improved pit latrines and simple pit latrines.[43] Public latrines are not considered to provide proper access, but shared latrines are. These standards raise the bar in terms of overall quality of provision globally. But the needs of young children and those who care for them are not adequately reflected here. It is worth looking more closely at how provision affects them in their daily lives.

a. Water supplies

Quantity versus quality

Supplies of uncontaminated water are critical to health, but water quantity is even more important than quality for maintaining children's health.[44] Contaminated water contributes to outbreaks of disease, but too little water makes it difficult to maintain the sanitary conditions that prevent contamination and which are essential for controlling the endemic disease that contributes so heavily to repeated illness and the death of many children.[45] Studies from urban areas in Bangladesh and Niger, for instance, find that the faecal contamination leading to diarrhoeal disease and intestinal parasites is more highly correlated to dirty hands (a good indicator of the accessibility of water supplies) than it is to the quality of drinking water.[46]

Accessibility of water

Too little attention is given to this important aspect. Distance to water points, regularity of supply and time spent waiting are serious concerns – especially for caregivers dealing with young children. Although 20 litres per person, per day is the WHO/UNICEF standard for household water consumption,[47] it has been estimated that at least 30–40 litres a day are needed per person if drinking, cooking, laundry and basic hygiene are all taken into account.[48] When water is at a distance and needs to be carried (or when it needs to be purchased from vendors), this is a prohibitive quantity, and many households with young children who technically have access to water actually make do on far less than they really need. Hands, food, utensils, floors, cooking surfaces and children are all less likely to be kept clean when water has to be carried any distance. A kilometre is an unreasonable distance to carry water by any standard. Even 100 metres, a distance frequently used to define adequate provision, fails to guarantee optimal use. In Malawi, it was found that water supply had to be brought to within a few yards of the house for the amounts of water used by caregivers to increase significantly.[49]

Westport, Connecticut; also Gardner, J M, S M Grantham-McGregor, J Himes and S Chang (1999), "Behaviour and development of stunted and non-stunted Jamaican children", *Journal of Child Psychology and Psychiatry and Allied Disciplines* Vol 40, No 5, pages 819–827.

34. Fernald, L C and S M Grantham-McGregor (1998), "Stress response in school-age children who have been growth retarded since early childhood", *American Journal of Clinical Nutrition* Vol 68, No 3, pages 691–698.

35. For example, Piaget, J (1952), *The Origins of Intelligence in Children*, International Universities Press, New York; also Montessori, M (1965), *Spontaneous Activity in Education*, Schocken, New York; and Wohlwill, J and H Heft (1987), "The physical environment and the development of the child" in Stokols, D and I Altman (editors), *Handbook of Environmental Psychology*, Wiley, New York.

36. See reference 28, Nicol (1998).

37. Doyle, B (1995), "Increasing education and other opportunities for girls and women with water, sanitation and hygiene", *Waterfront*, UNICEF–NY special issue, August.

38. In schools in Vietnam, the standard for drinking water availability was one litre of boiled water for every three students in the summer and one for every ten students in the winter; only 10 per cent of schools met this standard. Thirty per cent of schools had no latrines, 80 per cent had insufficient latrines and 75 per cent had latrines in bad condition – see Laugeri, L (1993), "Hygiene education and environmental sanitation in schools in Vietnam", WHO, EOS. Throughout Latin America, facilities were also found to be lacking or inadequate – see Burgers, L, M Simpson-Hebert, L Laugeri and L Clark (1993), "School sanitation and hygiene education in Latin America: summary report of a workshop on problems and options for improvement, Cali, Colombia", PAHO, WHO, IRC.

39. Unpublished baseline survey for the Dirha Suchana project, Save the Children–US, Dhaka, Bangladesh.

40. See the Convention on the Rights of the Child, Articles 6, 24 and 27.

41. WHO/UNICEF, Joint Monitoring

The effects on child health can be dramatic. In an urban settlement in Papua New Guinea, the presence of a standpipe within the compound was associated with a 56 per cent reduction in diarrhoea for children aged under five.(50) In Burkina Faso, mothers with a tap in their yard were three times more likely to use safe hygiene practices than those fetching water from wells outside their compound.(51) In urban Brazil, infants were five times more likely to die in households using public standpipes than in those with water piped to the house.(52)

Storing water

No matter how close the source, if water is not piped directly into a house or yard, it must be stored in containers. Even when water is piped to the house, if the flow is not regular it will have to be stored. This provides a number of opportunities for contamination. It is a particular problem in households with young children, who may dip dirty hands into a storage bucket or leave water scoops on the floor, contributing to contamination.(53) The prevalence of diarrhoea in small boys in Ethiopia was found to be associated significantly with drinking water obtained by dipping into storage containers; by contrast, the water source and amount of water consumed were not significant risk factors.(54) In a poor neighbourhood of Abidjan, Côte d'Ivoire, where drinking water is stored in most households, *E. coli* was found in 1 per cent of source water samples, but in 41 per cent of stored water samples.(55) In a slum settlement in Nairobi, uncovered water containers were the most significant factor influencing children's recovery from diarrhoea.(56) In peri-urban Peru, children in households with water stored in containers without a faucet were twice as likely to have a high incidence of diarrhoea as those who used containers with faucets.(57) By contrast, in a refugee camp in Malawi, when water was stored in containers with a cover and a spout, there was a 69 per cent reduction in faecal coliform levels in the water and 31 per cent less diarrhoea in children under five.(58) An appealing feature of having water piped regularly and directly into the house is that there is no need for a storage tank, and those using the water cannot inadvertently contaminate the supply.

b. Sanitation

Problems posed by inadequate water supplies are further complicated by poor sanitation, which can cause water to become contaminated and which greatly heightens the need for hygiene. Where infants and small children are concerned, the only safe sanitation methods are those that eliminate all possibility of contact with excreta. Safe stool disposal is far more effective as a safeguard against disease than any amount of hand-washing.(59) Yet almost half the world's households lack a sanitary means of disposing of human waste.

In urban areas, many low-income settlements are served, at best, by filthy, crowded public latrines that are distant from many of the dwellings they serve, causing many people to defecate in the open. Such arrangements are particularly challenging for young children and their caregivers. Taking a young child any distance for toileting is impractical, especially when there is likely to be a queue at the latrine. Even shared toilets, approved by WHO and UNICEF,

Programme for Water Supply and Sanitation (2000), *Global Water Supply and Sanitation Assessment, 2000 Report*, World Health Organization, Geneva.

42. Such sources include household connections to piped water, public standpipes, boreholes with hand pumps, protected dug wells, and springs and rainwater collection. Unprotected wells and springs, bottled water and water supplied by vendors or tanker trucks are not considered "improved" sources. In the case of bought water, this is not necessarily because of quality issues but because of concerns about access to sufficient quantities.

43. Service or bucket latrines, where excreta are manually removed, and latrines with an open pit do not meet the standard.

44. See reference 41.

45. A review of epidemiological studies found that increases in water quantity were associated with a 20 per cent reduction in diarrhoea, while provision of safe water was associated with a 15 per cent reduction – see Esrey, S, J Potash et al. (1991), "Effects of improved water supply and sanitation on ascariasis, diarrhoea, dracunculiasis, hookworm infection, schistosomiasis and trachoma", *Bulletin of the World Health Organization* Vol 69, No 5, pages 609–621; also Cairncross, S (1990), "Water supply and the urban poor" in Hardoy, J, S Cairncross and D Satterthwaite (editors), *The Poor Die Young: Housing and Health in Third World Cities*, Earthscan, London.

46. Henry, F J and Z Rahim (1990), "Transmission of diarrhoea in two crowded areas with different sanitary facilities in Dhaka, Bangladesh", *Journal of Tropical Medicine and Hygiene* Vol 93, No 2, pages 121–126; also Julvez, J, M A Bade et al. (1998), "Intestinal parasitic diseases in an urban environment in Sahel. A study in a district of Niamey, Niger", *Bulletin de la Société de Pathologie Exotique* Vol 91, No 5, pages 424–427.

47. See reference 41.

48. Godin, L (1987), "Préparation des projets urbains d'aménagement", World Bank, Washington DC. It should be stressed that this is considered a minimum for health.

49. Lindskog, P and J Lundqvist

Box 1: Sanitary practices in a Peruvian shanty town

In a densely populated shanty town in Lima, Peru, where water for the most part was purchased from tankers and where only some households had latrines, almost all children under the age of one were kept in nappies that were washed daily and rinsed at least three times to avoid nappy rash. The costs in terms of both water and time were a strong motivation for getting children out of nappies as soon as possible. Mothers considered potties the most hygienic solution and, in some cases, began training infants as young as six months old. But because mothers were busy, potty-training was inconsistent and it was common for children to defecate in their clothes – a transgression commonly greeted with shouting or slaps. As with nappies, faeces from potties were emptied into latrines in households that had them, but otherwise onto a rubbish dump or on a nearby hillside commonly used for defecation. Most mothers felt potties should be emptied and washed as soon as possible – but said that they were generally too busy to do this.

Only 20 per cent of small children actually used potties consistently and, in most cases, mothers allowed them to defecate directly onto the ground – although defecation near a neighbour's home was considered unacceptable. Faeces were sometimes left on the ground and sometimes scooped up and disposed of in a latrine or on a dump. Although children were generally wiped off, 30 per cent were found to retain some faecal matter on their clothes or bodies.

Latrines were considered unrealistic for children under four because of the large openings and the need for small children to be accompanied. Although some learned to manage latrines independently over time, most children over the age of three used the hillside, looking for a spot that was free of faeces and trash.

SOURCES: Huttly, S R, C F Lanata, B A Yeager, M Fukumoto et al. (1998), "Faeces, flies and fetor: findings from a Peruvian shanty town", *Revista Panamerican de Salud Publica* Vol 4, No 2, pages 75–79; also Yeager, B A C, S R Huttly, R Bartolini, M Rojas, C F Lanata et al. (1999), "Defecation practices of young children in a Peruvian shanty town", *Social Science and Medicine* Vol 49, No 4, pages 531–541.

(1998), *Why Poor Children Stay Sick: The Human Ecology of Child Health and Welfare in Rural Malawi"*, Scandinavian Institute of African Studies, Uppsala, Sweden.

50. Bukenya, G B and N Nwokolo (1991), "Compound hygiene, presence of standpipe and the risk of childhood diarrhoea in an urban settlement of Papua New Guinea", *International Journal of Epidemiology* Vol 20, No 2, pages 534–539.

51. Curtis, V, B Kanki et al. (1997), "Dirt and diarrhoea: formative research in hygiene promotion programmes", *Health Policy and Planning* Vol 12, No 2, pages 122–131.

52. Victoria, C G et al. (1988), "Water supply, sanitation and housing in relation to the risk of infant mortality from diarrhoea,", *International Journal of Epidemiology* Vol 17, No 3, pages 651–654.

53. See reference 49; also Roberts, L, Y Chartier et al. (2001), "Keeping water clean in a Malawi refugee camp: a randomized intervention trial", *Bulletin of the World Health Organization* Vol 79, No 4, pages 280–287.

can present problems for young children. Maintenance frequently becomes an issue;[60] neighbours resent it when children leave things dirty, and children themselves are at higher risk of faecal contact than they would be with private facilities. Pit latrines present a particular problem. The darkness, smelliness and large openings make their use unpleasant and even frightening for young children. Reports from Malawi, Nepal, Burkina Faso and India claim that children rarely use latrines before they are six or eight because of the risk of falling into the pit.[61] A survey by UNICEF's India office found that only 1 per cent of children under the age of six use latrines, that the stools of another 5 per cent are thrown into latrines, and that the remainder end up in drains, on the streets or in yards.[62] Considering the number of young children in any poor settlement, it is no wonder that the surroundings quickly become fouled, even in situations where provision meets international standards for "improved" provision. Meeting the needs of children means providing toilets that children are comfortable using – as in Pune, India, where specially designed toilet blocks were constructed for children and included such features as smaller squat plates, handles to prevent overbalancing, and proper maintenance.[63]

Strong links have been found in many urban communities between the quality of sanitary provision and rates of diarrhoea. In urban Brazil, the most significant risk factor for diarrhoea, next to the age of the child (under two), was the lack of sanitation facilities.[64] In Pakistan, infants in households with soak pits were 60 per cent more likely to die than those with toilets connected to sewers.[65] In Sri Lanka and in Cebu in the Philippines, unsanitary disposal of

children's faeces, linked to the absence of adequate sanitary provision, was associated with a higher incidence of diarrhoea in young children relative to children in households that followed sanitary practices.(66) Similarly, the higher prevalence of intestinal parasites in urban children has been associated repeatedly with shared toilets or a lack of connection to city sewer systems.(67)

Multi-country research published in 1996 explored whether incremental improvements in water and sanitation resulted in incremental health effects on diarrhoea and nutritional status. Improvements in sanitation were found to have a greater impact than improvements in water provision; in fact, benefits from improved water were felt only when sanitation was also improved. And the effects of improved provision were greater for urban than for rural dwellers.(68) Other research looking at the benefits of partial coverage has produced mixed findings. Work in urban Africa found that improved provision to a small number of households in an area may not protect even those families from infection when the overall level of faecal contamination in the environment is high.(69) Other research shows that even partial coverage reduces overall faecal contamination and also contact between children and opportunities for infection.(70) Clearly, it is important for provision to reach some critical "tipping point" for things to change substantially. Research comparing five slum communities in Visakhapatnam, India, for instance, found similar levels of morbidity despite differences in provision; it was hypothesized that, while progress had been made in environmental improvements in some neighbourhoods, they were not yet of sufficient magnitude to have a significant effect on morbidity rates.(71)

Drainage and waste collection

Problems with sanitation are intensified when there is inadequate drainage and waste removal. Where sanitation is poor, many people must defecate in the open, or into plastic bags or paper thrown out with the household garbage. Excreta can accumulate rapidly in open areas and on garbage piles. Uncollected garbage is also frequently dumped in drainage ways, which quickly become clogged. When wastewater and stormwater cannot be easily drained, flooding spreads waste and excreta widely throughout the surrounding area.

Inadequate drainage and waste collection pose particular problems for children, who tend to play wherever there are interesting opportunities for exploration and who may be drawn to wade or play in standing water and drainage ditches or to scavenge in piles of garbage. In many communities, it is impossible for children to play outdoors and avoid these hazards (Box 2). Children between 5 and 14, for instance, are disproportionately affected by helminths and by such water-based diseases as bilharzia.(72)

VI. ALTERNATIVES TO PROVISION

a. Why not just treat disease when it occurs?

GIVEN THE COST of solutions involving infrastructure, curative approaches such as antibiotics and oral rehydration therapy are

54. Teklemariam, S, T Getaneh et al. (2000), "Environmental determinants of diarrhoeal morbidity in under-five children, Keffa-Sheka zone, southwest Ethiopia", *Ethiopian Medical Journal* Vol 38, No 1, pages 27–34.

55. Dunne, E F, H Angoran-Benie et al. (2001), "Is drinking water in Abidjan, Côte d'Ivoire, safe for infant formula?", *Journal of Acquired Immune Deficiency Syndrome* Vol 28, No 4, pages 393–398.

56. Mirza, Nazrat M, Laura E Caulfield, Robert E Black and William M Macharia (1997), "Risk factors for diarrhoeal duration", *American Journal of Epidemiology* Vol 146, No 9, pages 776–785.

57. Yeager, B A C, S R A Huttly, R Bartolini, M Rojas, C F Lanata et al. (1999), "Defecation practices of young children in a Peruvian shanty town", *Social Science and Medicine* Vol 49, No 4, pages 531–554.

58. See reference 53, Roberts, Chartier et al. (2001).

59. Curtis, V, S Cairncross et al. (2000), "Domestic hygiene and diarrhoea – pinpointing the problem", *Tropical Medicine & International Health* Vol 5, No 1, pages 22–32.

60. Grimason, A M, K Davison et al. (2000), "Problems associated with the use of pit latrines in Blantyre, Republic of Malawi", *Journal of the Royal Society of Health* Vol 120, No 3, pages 175–182.

61. Curtis, V, B Kanki et al. (1995), "Potties, pits and pipes: explaining hygiene behaviour in Burkina Faso", *Social Science and Medicine* Vol 41, No 3, pages 383–393; also see reference 49; National Shack Dwellers Federation, Mahila Milan, SPARC (1997), *Toilet Talk* No 1, SPARC, Bombay, December; and "Urban basic services, a community profile, Biratnagar, Nepal", prepared for Biratnagar Municipality, Ministry of Local Development, HMG/Nepal and UNICEF.

62. UNICEF (2000) "Multiple indicator survey", UNICEF, Delhi.

63. Burra, Sundar and Sheela Patel (2002), "Community toilets in Pune and other Indian cities", *PLA Notes* 44, Special Issue on Local Government and Participation, IIED, London.

Box 2: Sanitary conditions in Banshighat, an informal settlement in Kathmandu, Nepal

The informal settlement of Banshighat in Kathmandu, Nepal, is criss-crossed by foul-smelling open drains which run down to the nearby river, carrying wastewater from other parts of the city as well as from this community. Because there is no provision for waste removal, all local garbage is also dumped into these drains. Plastic bags, orange peel and broken glass litter the banks. Although most people in the community use the riverbank for defecation, some households have latrines on the way down to the river, and these also empty into the drains. However, small children in Banshighat do not use latrines and they are not allowed down by the river, so caregivers throw their excreta into the drains – the simplest way to keep the narrow walkways clean. This means that faecal matter is present in the drains throughout the community.

Parents are aware of the health hazard that these drains present, but their awareness is no match for their children's drive to play. Even the most vigilant caregivers have trouble protecting children from their contaminated environment. One mother described to a researcher all the measures she took to ensure that her children did not touch water from the drains. While she spoke, her son dropped his ball into the drain behind her. He jumped in, retrieved the ball and continued throwing it back and forth to other children. Another small boy was observed driving his "car" – a small slab of wood – down to the edge of the drain, through the water and out the other side, while his mother washed clothes nearby.

The drains are especially hazardous for children just learning to walk. Everyone watches these little ones carefully, said one mother, but inevitably they trip and fall in at some point. They are scolded or beaten when they fall in, in an attempt to impress upon them the importance of avoiding the drains. These and the generally dirty conditions present a constant threat to health for small children in Banshighat, with diarrhoea, worm infestations, skin problems and eye infections being a routine part of their lives.

SOURCE: Save the Children Norway (2002), "Banshighat: preparatory research for ECD programming", unpublished report, Kathmandu, Nepal.

often viewed as more reasonable. Without these measures, millions more lives would be lost. But medical treatment is not a justifiable alternative to an adequate provision of water and sanitation. Curative responses do not prevent re-infection nor do they eliminate days lost to illness, with the accompanying setbacks for children's overall health and development. A focus on medical solutions to water and sanitation-related problems also ignores the many non-health implications of poor provision – the time burdens for caregivers, the constraints on play for children and the insult to human dignity. Finally, many health care responses require the intervention of trained medical personnel and present a continual burden for already overtaxed health services. Adequate provision of water and sanitation, by preventing a significant proportion of disease in low-income settlements, would increase the capacity of health services to manage other pressing health problems.

b. What about hygiene education?

The key to children's environmental health problems is often assumed to lie in the education of caregivers in hygiene and other protective measures. Practices such as hand-washing have been shown to result in impressive reductions in disease.[73] Experience also shows that, in the absence of good hygiene, improved provision may have a minimal effect on health.

However, it is still unclear how changes in health behaviour

64. Vasquez, M L, M Mosquera et al. (1999), "Incidence and risk factors for diarrhoea and acute respiratory infections in urban communities of Pernambuco, Brazil", *Cad Saude Publica* Vol 15, No 1, pages 163–171.

65. Agha, S (2000), "The determinants of infant mortality in Pakistan", *Social Science and Medicine* Vol 51, pages 199–208.

66. Mertens, T E, S Jaffar et al. (1992), "Excreta disposal behaviour and latrine ownership in relation to the risk of childhood diarrhoea in Sri Lanka", *International Journal of Epidemiology* Vol 21, No 6, pages 1157–1164; also Baltazar, J C and F S Solon (1989), "Disposal of faeces of children under two years old and diarrhoea incidence: a case control study", *International Journal of Epidemiology* Vol 18, No 4, pages S16–19.

67. See reference 13, Mahfouz et al. (1997); also reference 13, Ludwig et al. (1999); and reference 5, Curtale et al. (1998).

are best effected. A number of studies have shown that information alone does not reliably change behaviour, and that efforts to improve hygiene through education may have little effect in the absence of supportive provision. In a Lima shanty town, for instance, where knowledge of the importance of hygiene practices was high, only 13 per cent of "faecal contamination episodes" were found to be interrupted by washing. Researchers concluded that, where water is scarce, education is unlikely to change hygiene practices.[74] In Burkina Faso, research on factors influencing hygiene behaviour found that the location of water sources was more important than health education, income, maternal education or culture.[75] In Sri Lanka, a case control study concluded that latrine ownership may be a necessary condition for improving safe stool disposal.[76]

Beliefs that run counter to formal biomedical knowledge may be quite resistant to change. In urban Karachi, for instance, infant diarrhoea is frequently considered a "normal" event related to teething or the weather.[77] Curtis and colleagues point out that simply telling people about the likely health benefits of a given practice is not likely to provide the motivation to change lifelong habits. When mothers believe that diarrhoea is the result of teething or of sitting on damp ground, explanations involving microbes are unlikely to have a great impact.[78] But non-compliance with hygienic practice is not always a question of conflicting beliefs. It may be a matter of time and energy – as in Malawi, where water use increased significantly only when supplies were brought very close to the house;[79] or the Dominican Republic, where mothers revealed that in many cases they were simply "too tired to boil water".[80]

WHO and UNICEF remind us that "*…the simple act of washing hands with soap and water can reduce diarrhoeal disease transmission by one-third.*"[81] Such statements tend to overlook the fact that keeping two- and three-year-olds clean in a contaminated environment is far from "simple". It can call for constant vigilance and even for unrealistic restrictions on children's play and socialization (see Box 2). Another critical consideration is the fact that caregivers seldom face these problems one at a time; environmental risk factors generally exist in clusters. It might be possible for caregivers to respond effectively to any one of them, but coping hygienically with daily challenges in the absence of reasonable provision can mean a number of time-consuming tasks, including:

- obtaining sufficient supplies of water for hygienic living;
- ensuring that stored water does not become contaminated;
- washing potties or nappies and/or disposing safely of small children's stools (often loose stools, and often those of more than one child);
- ensuring that latrines are kept clean;
- ensuring that hands (and often the body) are washed every time a small child defecates or eats; and
- keeping small children away from local sources of contamination as they play.

In addition, measures must be taken to avoid the contamination of food. When these challenges are compounded by crowded and unfinished housing, an absence of safe play space, long

68. Esrey, S A (1996), "Water, waste and well-being: a multi-country study", *American Journal of Epidemiology* Vol 143, No 6, pages 608–623.

69. Feacham, R, M Guy et al. (1983), "Excreta disposal facilities and intestinal parasitism in urban Africa: preliminary studies in Botswana, Ghana and Zambia", *Transactions of the Royal Society of Tropical Medicine and Hygiene* Vol 77, No 4, pages 515–521.

70. Root, G P (2001), "Sanitation, community environments and childhood diarrhoea in rural Zimbabwe", *Journal of Health, Population and Nutrition* Vol 19, No 2, pages 73–82.

71. Asthana, Sheena (1995), "Variations in poverty and health between slum settlements: contradictory findings from Visakhapatnam, India", *Social Science and Medicine* Vol 40, No 2, pages 177–188.

72. See reference 14.

73. See, for instance, reference 59; also Vaz, L and P Jha (2001), "Note on the health impact of water and sanitation services", CMH Working Paper Series No WG5:23, Commission on Macroeconomics and Health, WHO, Geneva.

74. Gilman, R H, G S Marquis, G Ventura, M Campos et al. (1993), "Water cost and availability: key determinants of family hygiene in a Peruvian shanty town", *American Journal of Public Health* Vol 83, No 11, pages 1554–1558.

75. See reference 51.

76. See reference 66, Mertens et al.(1992).

77. Qureshi, A F and M A Lobo (1994), "Socio-anthropological determinants and home management in childhood diarrhoea in a squatter settlement of Karachi, Pakistan", *Journal of Tropical Pediatrics* Vol 40, December, pages 378–380.

78. See reference 51.

79. See reference 49.

80. Mclennan, J D (2000), "To boil or not: drinking water for children in a peri-urban barrio", *Social Science and Medicine* Vol 51, No 8, pages 1211–1220.

81. See reference 41.

distances to work and services, and a lack of child care, the difficulties can become overwhelming and unmanageable. It becomes far-fetched to assume in these complex situations that children's health can reasonably be protected by health information in the absence of appropriate provision.

VII. THE COST-EFFECTIVENESS OF PROVISION

ANALYSES OF COST-EFFECTIVENESS show that the results gained through the provision of water and sanitation infrastructure are more costly than those from health service interventions and health education. However, there is a debate about the capacity of traditional cost-benefit analyses to represent the situation accurately. Non-health benefits are generally not considered, and nor do these estimates tend to take into account the amounts that poor people are willing to spend themselves to ensure reasonable access to water and sanitation.[82]

Moreover, calculations about the affordability or cost-effectiveness of improving provision seldom include a consideration of the costs of not improving provision. How does one assess the value of time spent waiting in line for water or the cost of a child's multiple episodes of diarrhoea? What price can be placed on malnutrition and diminished capacity over a lifetime? What is the cost to human comfort and dignity of living in fetid surroundings or squatting in public to defecate?

Finally, it is not clear that cost-effectiveness is an appropriate criterion in this case. The situation of millions of children in urban slums around the world should properly be considered a human-rights emergency, not a matter of business as usual. The total annual investment in water and sanitation for Asia, Africa and Latin America between 1990 and 2000 (both national investment and external aid) averaged US$ 16 billion.[83] It is estimated by the US government that the costs of the temporary occupation of Iraq (not including reconstruction) could be three times this amount for one year.[84] UNICEF's analysis of data from nearly 150 countries shows that disparities and pervasive poverty are directly related to under-investment in the needs of children.[85] Such investment cannot be considered an extravagance but, rather, an essential means of ensuring long-term development.

VIII. CONCLUSIONS

DIARRHOEA AND INTESTINAL parasites still kill, sicken and weaken high numbers of children every year. They contribute also to the malnutrition and stunting that continue to affect over one-third of the world's children and that compromise their capacity to realize their potential and to contribute fully to their societies. These health problems and their wider implications are related to inadequacies in the provision of water and sanitation, which may fail in critical ways to meet the needs of young children and those who care for them, even when officially deemed to be "adequate"

82. Hardoy, J, D Mitlin and D Satterthwaite (2001), *Environmental Problems in an Urbanizing World*, Earthscan, London; also see reference 73, Vaz and Jha (2001).

83. See reference 41.

84. usgovinfo.about.com/library/weekly/aairaqwarcost.htm

85. UNICEF (2002), *Progress Since the World Summit for Children: a Statistical Review*, UNICEF, New York.

or "improved". The crisis is especially severe in poor urban settlements, where concentrations of people and wastes create environments that undermine health and human dignity and add considerably to the challenges of daily survival. Any attempt to find cost-effective solutions to this problem must consider not only the direct but also the indirect costs of poor provision – and not only the immediate but also the long-term outcomes of its absence. It is impossible to separate the development of low-income countries from the health and development of their children. The cost to the world of ensuring the kind of provision that actually meets children's right to a clean, supportive environment is considerable – but it is unquestionably a thrifty move when it is balanced against the cost of neglecting to do so.