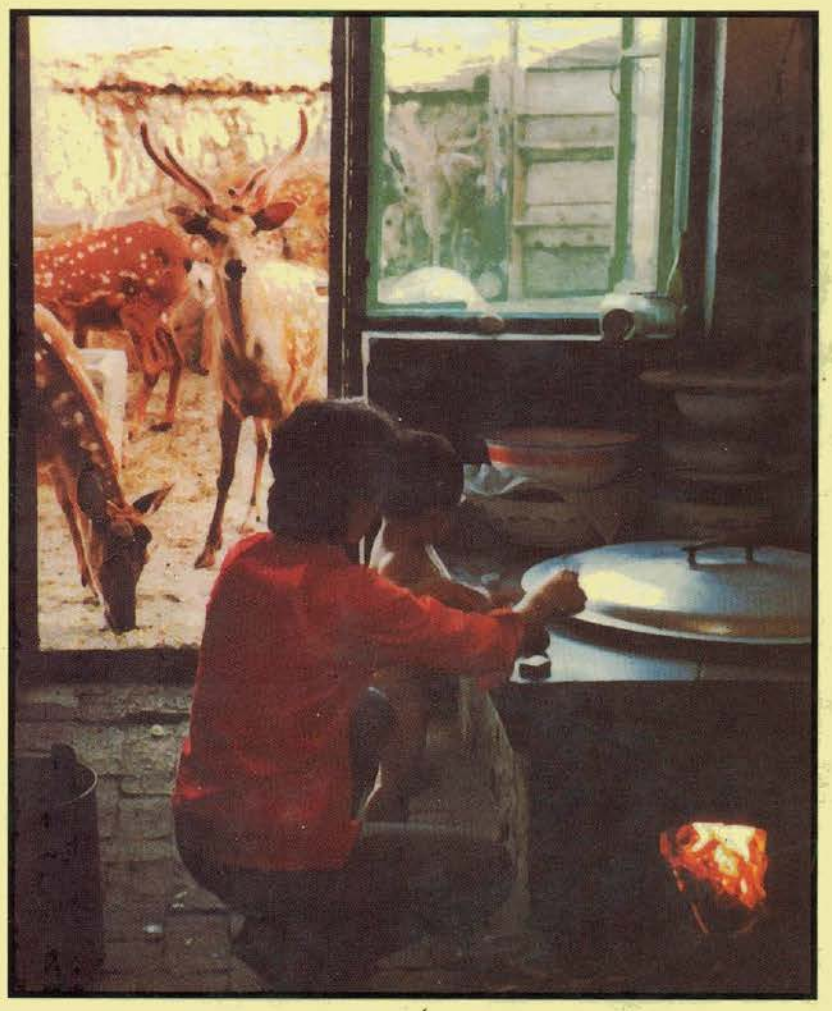
Domestic Environment and Health of Women and Children

Edited by
H N B Gopalan and Sumeet Saksena



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The contents of this publication have been written by a team of researchers.

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Contents

Preface

There is much to cheer about when one looks at the trends in human health over the last 20 years. In many parts of the world, especially in the developing regions, people are living longer and healthier lives, thanks to modern technology and better resource management practices. In addition, better food, water, and housing, fewer instances of labour exploitation, more efficient and safer working places, improved access to primary health care, and reduced levels of pollution have also contributed to improving the quality of life of both the rich and the poor.

However, although global health trends are seemingly positive, they tend to obscure the serious disparities that occur between the more and less advantaged members of any given society. Not all regions, and not all population groups are equal beneficiaries of the recent improvements. The poor, even in wealthier nations, suffer far worse health than the wealthy. And among the poor, women and children suffer more than men do. This gender specificity of environmental effects mainly arises from pre-existing gender inequalities in the division of labour; the intra-household distribution of subsistence resources; access to productive resources, other assets, income-earning opportunities; and participation in decision-making. The disparities across the rich and poor nations are primarily due to environment-based risks such as vector-borne diseases and indoor air pollution, most of which are intimately linked in turn to the domestic environment.

Understanding the complex links between the environment and health is crucial and a challenging task. The relative role that various factors play in influencing health are difficult to identify, and even more difficult to quantify in a manner that can help policy analysts. For example, poor nutrition makes women and children more susceptible to pollution, but it is difficult to say to what extent this happens.

While the domestic environment accounts for almost 30% of the global burden of disease, the good news is that modest interventions can help reduce this burden by at least 20%. Such interventions include improved access to clean water, efficient disposal of garbage, promoting the use of clean cooking fuels, controlling insect and animal vectors, and last but not the least, effective education and awareness programmes.

Implementing such programmes will require a policy framework that recognizes the intimate link between environment and health. More importantly, policy analysis tools need to incorporate and internalize appropriate and scientifically correct indicators of environmental exposure. Health concerns should be brought to the fore in environmental decision-making, instead of leaving them as implicit goals. Decision makers should appreciate that since budgets are limited 'environmental investments' like any investment should be approached with a view to achieving the highest rate of return possible. In the developing world, this means that the bulk of our efforts and resources should be aimed at solving the health problems of a traditional nature.

Human health is therefore not just a social goal but an environmental one as well. This implies that environmental regulatory agencies have an important role to share with the health agencies as protectors of human health. This, in turn, implies that the success of environmental policies, programmes, and projects should be measured in terms of reduction in the incidence of certain diseases, and not in terms of improvement in ambient quality, or worse, just in terms of number of control devices installed and effectively operational. While the latter two indicators of progress may be a necessary condition for success they are by no means sufficient. Health, for the environment agencies, has to be an explicit, operationalizable goal, and not merely an implicit goal.

Health agencies should be encouraged to lay greater emphasis on social and preventive medicine. At the same time, the greatest challenge for developing societies is to wisely and sustainably manage the transition from traditional risks to those of a more modern nature such as toxic pollution. The challenge lies in quickly eliminating the traditional risks while restraining the newer forms of risks associated with unsustainable industrial and economic development.

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Executive summary

The household environment of the poor people, especially women and children in developing countries, carries the biggest risks to health. These risks are typically 'traditional' in nature, in the sense that they are associated with a lack of development. The World Bank in 1993 calculated how much of the total burden of disease could be attributed to household environmental problems including crowding, lack of sanitation and garbage disposal, indoor air pollution, and vector-breeding grounds. The study concluded that 30% of the burden of disease could be averted by improvements in the household environment and of these, 20% are just modest interventions. Some of these interventions are mentioned in Table 1.

Gender specificity of environmental effects mainly arises from pre-existing gender inequalities in division of labour; intra-household distribution of subsistence resources; access to productive resources, other assets; income-earning opportunities; and participation in decision-making.

This book is an assessment of the state of knowledge, contemporary situation, and status of scientific data that links domestic environmental parameters to the health of women and

Table 1
Improving the household environment: benefits to health

Disease	DALYs* (millions per year)	Relevant environmental problem	Percentage of DALYs averted by environmental interventions	Prevention strategies
Acute respiratory infections (ARI)	119	Indoor air pollution, crowding	15	• Improve ventilation • Improve cookstoves • Provide electricity to rural households and urban poor
Diarrhoea	99	Sanitation, water supply, hygiene	40	• Improve quality of drinking water • Increase the quantity of water used by improving accessibility and reliability of water supply • Improve sanitation and hygiene (behaviour changes include washing hands, boiling water, and preventing casual use of unprotected sources)
Intestinal worms	18	Sanitation, water supply, hygiene	40	• Same as for diarrhoea • Reduce need for contact with infected water
Malaria	—	Water supply	—	• Improve surface water management • Destroy breeding sites of insects • Reduce the need to visit breeding sites • Use mosquito netting
Dengue fever	—	Water supply, garbage collection	—	• Improve surface water management • Destroy breeding sites of insects • Reduce the need to visit breeding sites • Use mosquito netting

* Disability adjusted life years

Contd...

Disease	DALYs (millions per year)	Relevant environmental problem	Percentage of DALYs averted by environmental interventions	Prevention strategies
Tropical cluster (includes schistosomiasis and filariasis)	8	Sanitation, garbage disposal, vector breeding around the home	30	• Reduce need for contact with infected water • Control snail population • Filter water
Tuberculosis	46	Crowding	10	• Improve housing quality and quantity
Chronic respiratory diseases	41	Indoor air pollution	15	• Same as for ARIs

Source. The World Bank 1993. *World Development Report: Investing in Health*. Oxford: Oxford University Press. 329 pp.

children. It aims to identify critical knowledge gaps and needed research. The book provides policy options, guidelines, possible interventions, and regulatory tools for improving health of women and children.

Existing scientific literature and policy documents pertaining to the developing world have been reviewed. Estimates of the magnitude and types of 'human exposure' (the extent to which the causal factor is present) are made based on secondary data available in census surveys and documents published by the United Nations and other agencies, including non-governmental, inter-governmental, and governmental organizations. The estimation is based on modern analytical tools such as total and integrated individual daily exposure, burden of disease, DALYs, etc. used by specialists in risk assessment.

The following topics have been reviewed in this book.

- Housing
- Fuel shortage and indoor pollution
- Water supply and sanitation
- Nutritional status

A few important epidemiological studies and case studies that attempt to alleviate health problems have also been highlighted. Given that the health problems associated with the domestic environment mainly affect women and children, gender issues are a strong

component of this study. The book provides examples of how social and political backgrounds determine women's activity patterns at home and at work, and how this consequently affects their health.

Finally, the book recommends interventions and forwards arguments to modify current environmental regulatory tools and policies to achieve sustainable health improvement for women and children.

Housing

This chapter reviews the key policy and research trends that have helped define the relationship between housing and health in the developing countries (DCs). Significant gap has been identified between problem articulation in the policy domain, which claims significant differential vulnerability of women and children; and the medical and scientific literature which is rather sparse in this sector. Exposure studies reveal the availability of limited data on the actual exposure levels of women and children to domestic health risks in DCs. Further, only some health risks within the major disease categories are fairly well-defined. There is, therefore, a significant gap in the medical and scientific literature that needs to be filled with focused research.

The key disease groups that were identified to contribute to the housing–health linkage include respiratory infections, diarrhoeal diseases, malaria, flavivirus infections, Chagas disease, intestinal helminthic infections, and household injury. Data availability and its quality across these areas was found to be highly variable.

A review of the current analytical framework in this area concluded that there was need for an alternative formulation and a new research agenda focusing on DC problems and priorities. A series of processes, environmental and technical interventions were identified apart from the need for gender sensitivity and child-centredness in both research and pilot implementation programmes.

Within the international community, the challenge of crosscutting problem areas will be inter-agency coordination, research definition, and programme design. There is clearly a role for additional action research to close significant gaps in identified areas such as exposure studies, risk mitigation, and exposure modification in the domestic environment, and in gender- and child-centred programmes.

Biofuels

Some 3.5 billion people, mostly in rural areas and also in poor sections of many cities, continue to rely on traditional fuels and stoves for cooking and space heating. Emissions from such sources contain very harmful pollutants, and combined with the confined space and long duration of cooking, the resultant exposures are extremely high by any standard. Daily averages often exceed World Health Organization (WHO) guidelines by a factor of 10 or more. Dangerous as the outdoor air can be to health, indoor air pollution actually poses a greater health risk at the global level. The global exposure is estimated on the basis of typical pollutant levels (concentrations) in the micro-environments, the time spent by various population groups in these micro-environments, and the size of these groups. From such an analysis, it is evident that about 77% of the global exposure to particulates occurs in indoor environments in the DCs. Epidemiological research in the DCs have linked exposure to indoor air pollution from traditional fuels with four major categories of illness: ARI in children, chronic obstructive lung diseases such as asthma and chronic bronchitis, lung cancer, and adverse pregnancy outcomes. Of these, ARI appears to have the greatest health impact in terms of the number of people affected and the time lost due to illness, especially in children younger than age five.

Based on extrapolations of health effects in developed countries, WHO has estimated that 2.7–3.0 million premature deaths (five per cent to six per cent of annual global deaths) occur due to outdoor and indoor air pollution. Using one methodology, it has been estimated that of the 3 million premature deaths due to air pollution, 2.8 million are due to indoor pollution. It has been estimated that the largest number of deaths will occur in India, followed by sub-Saharan Africa. As regards deaths due to indoor exposure, 90% of them will occur in the DCs. The possible interventions for reducing indoor air pollution include (but are not limited to)

- use of cleaner fuels such as kerosene, liquified petroleum gas, and processed biofuels (charcoal and biogas),
- lower emissions from stoves by improving combustion through secondary air and use of fuel-efficient stoves,
- lower household concentrations by improving ventilation and installation of chimneys or flues,
- lower exposure by improving kitchen design: move kitchens outside or establish communal kitchens, and

- change behavioural patterns such as reducing the time spent in kitchen with children, or during pregnancy and avoid sleeping or resting close to the fire.

Based on the relative importance of each disease and difficulties of measuring them, research studies on ARI in young children and adverse pregnancy outcomes have the highest priority. The actual effectiveness of various interventions (smokeless stoves, clean fuels, better ventilation, etc.) in reducing the incidence of these diseases should be explored.

The following actions may be considered by the health ministry and related institutions.

- Improve awareness by education and training for improved kitchen hygiene as part of primary health care package, child health package, maternal and child health package, etc.
- Consider co-funding epidemiological research and exposure–reduction actions.

The following actions may be considered by environmental agencies.

- Develop exposure atlases detailing regions of highest exposure and best potential for exposure–reduction which involves
  - collection and organization of information on fuel-use patterns in both rural and urban, and identifying gaps in order to implement needed additional data gathering,
  - collection of similar information on household conditions relevant to exposures, and
  - coordination with agencies compiling data on outdoor pollution levels.
- Promote environmental indicators for access to clean household air which include access to clean fuels and ventilation.

Water and sanitation

Owing to the International Drinking Water Supply and Sanitation Decade (IDWSSD), over the last decade-and-a-half, the water and sanitation (W&S) sector has received considerable importance. Prior to the launch of IDWSSD, the W&S scenario in the DCs was poor and limited literature was available. The existing literature focuses mainly on issues related to physical aspects primarily focusing on achievements in terms of access. The review of literature indicates that it has been able to document the impact of W&S interventions only

partially. Most of the literature focused on water-borne diseases in general, and diarrhoea, in particular. It has been estimated that as many as 80% of all diseases in the world are associated with water usage or poor environmental hygiene. Various risk factors which influence the water-borne diseases are studied, and gender-related health risks highlighted. The risks and impact of water-borne diseases on women especially during pregnancy are discussed in the form of case studies. It was also estimated that about 90% of the current diarrhoeal and malarial disease burden could be avoided if the environmental conditions such as safe W&S services are improved. Globally, infectious and parasitic diseases cause 23% of DALYs, but it varies enormously from region to region. Climatic factors influence the emergence and re-emergence of infectious diseases, in addition to multiple human, biological, and ecological determinants.

Women as primary users of W&S facilities are the ones who are most affected by the lack or inadequacy of these facilities. There is voluminous literature on women's role and responsibilities in relation to W&S provision and use. However, little research has been carried out to establish the effects on women of insufficient and poor W&S quality in terms of household coping strategies, the health impact of carrying water or differential impact on women due to water-borne diseases . Moreover, considerable effort has gone into documenting the technological innovations. Not much has been done on determining the effect on health of women and children in operating inefficient technologies *viz.* lifting water from wells, operating heavy handle handpumps, etc. Thus, the need here, is to focus on determining the gender-specific health impacts of W&S facilities.

Although the number of people without safe W&S facilities dropped during 1990–1994, it increased in Africa, Latin America, and the Caribbean. Almost all of the coverage gains have been in Asia and the Pacific. The health consequences resulting from the deprivation caused by this inequity are sometimes considerable, as evidenced by the infant mortality rates of rich and poor – which may vary between 2 and 10 times in magnitude and the large numbers of urban poor who are at high risk from epidemic diarrhoeal diseases such as cholera.

Nutrition

Protein energy malnutrition (PEM), iron deficiency anaemia, iodine deficiency disorders, and vitamin A deficiency are the major

nutritional deficiency disorders of concern in the DCs. While all of them show gender differentials in prevalence and severity, the prevalence of PEM is significantly higher among women in South Asia. Iron deficiency anaemia and iodine deficiency goitre are more prevalent among adult women than men, though vitamin A deficiency appears to be more prevalent among boys than girls.

Women's deprivation of nutrition and health care has consequences upon their children as well. Women's nutrition during pregnancy reflects on the prevalence of low birth weight (LBW) babies and this varies across the globe. With the decline in income of the countries, the prevalence of LBW babies also increases. DCs have a higher prevalence of LBW babies. The prevalence of undernutrition among children under-five also follows a similar trend. Although maternal malnutrition is a prime factor in introducing undernutrition to the under-five children, it is not the only risk factor.

There are certain major forces within the household which, either individually or in complex relationships with others, act as driving forces and create varying amounts of pressure on women throughout their life cycles. Thus, certain living conditions are created which expose women to various risks that initiate or accelerate nutritional deficiency. This, in turn, increases the risk of intra-uterine undernutrition (foetal) for the future generation. However, the driving forces prevailing in the domestic environment are also constantly influenced by the forces located in the environment outside. The commonly understood driving forces are rooted in the economic and non-economic arena of the domestic environment. The forces which originate in the economic basis of the household are low family income, employment status, terms and conditions at work, criticality of women's income, and lack of control over it, poor access to maternal and general health care services, and information and education. Similarly in the socio-cultural context of family, women's roles and status, their work within the house, lack of human or technological support network, and the disappearance of traditional knowledge and practices to keep up health and nutrition are the major forces.

Women, despite being denied just social status in many aspects of their lives, are considered as 'the key' to ensuring food security at the household level as food producers, food providers, and contributors to household nutrition security. The policy recommendations for improving women's health are classified in three broad areas.

1. Women's physical and human capital needs to be increased. Women's ability to produce food can be enhanced by improving their access to resources, technology, and information. Literacy

training for women and education for girls will increase productivity.

2. Policy-makers must increase women's ability to generate income to maximize the benefits of women's income for household food security and nutrition. Strategies should aim at increasing women's productivity both in paid work and in domestic production so that women can increase their incomes without sacrificing additional time, their children's welfare, or their own health and nutritional status.
3. The policies must protect women's health and nutritional status to allow women to fulfil their productive and reproductive roles. Development of safety net programmes for women should increase women's income-earning potential while reducing the energy or time intensity of their activities.

In brief, understanding women's situation within the household becomes a prime requisite for the formulation of policies regarding their nutrition. Not only is data on women still seen as only marginally relevant to policy-making, reliable sources for such data are also lacking in developing countries. Moreover, gender-disaggregated data alone cannot provide insights into the social processes that determine the differential impacts of policies on women and men. For policy-making, such data must be accompanied by analytical framework to understand gender relations. There is also a need for gender-friendly epidemiological research and filling in gaps that exist in formulation of policies. Studies can be designed incorporating gender-just approaches in various dimensions of the problem of women's nutrition *vis-à-vis* domestic environment. Simultaneously, gender sensitization of the government machinery is yet another need. This may include methodological analysis of census data, incorporation of gender indicators into the database of various policies related to economy or poverty, labour, food, and health including nutrition and education.

Introduction

Health is of concern for almost every sector in the society. The health sector is responsible for sustainable health improvements. It also has an important role as an advocate and a guide for healthy development. Associated with this, appropriate development in the agricultural, industrial, and energy sectors will result in such health improvements.

Environment and human health

The word 'environment' refers to whatever surrounds an object or some other entity. Humans experience the environment in which they live as an assemblage of physical, chemical, biological, social, cultural, and economic conditions which differ according to local geography, infrastructure, season, time of day, and activity undertaken. This book emphasizes on the impacts of household environmental conditions on health, and on the social and economic conditions that act as 'driving forces' and put 'pressures' on the environment.

The risk transition

Environmental threats can be classified into 'traditional hazards' associated with lack of development, and 'modern hazards' associated with unsustainable development (Smith 1991). The changing pattern of environmental health hazards and associated health risks – moving from 'traditional' to 'modern' with time and economic development – has been called the 'risk transition'.

One of the differences between traditional and modern environmental health hazards is that the former is often classified as diseases. For example, a villager drinks polluted water and gets an attack of diarrhoea. In this case, diarrhoeal incidence can be a relatively useful measure of the relevant risk. For many modern environmental health hazards, it would however take a long time for the health effect to manifest itself. A cancer-causing chemical released into the environment today, may not reach a person until it has passed through the food chain for months or years, for instance, and even then may not cause the development of a noticeable tumour for decades. So, for modern environmental health hazards, understanding the environmental pathways through which the hazards move is particularly important.

Traditional environmental health hazards related to poverty and 'insufficient' development include

- lack of access to safe drinking water;
- inadequate basic sanitation in the household and the community;
- food contamination with pathogens;
- indoor air pollution from cooking and heating using coal or biomass fuel;
- inadequate solid waste disposal;
- occupational injury hazards in agriculture and cottage industries;
- natural disasters including floods, droughts, and earthquakes; and
- disease vectors, mainly insects and rodents.

Modern environmental health hazards are related to rapid development that lacks adequate health–environment safeguards along with unsustainable consumption of natural resources. These hazards include

- water pollution from populated areas, industry, and intensive agriculture;
- urban air pollution from motor cars, coal power stations, and industry;
- solid and hazardous waste accumulation;

- chemical and radiation hazards due to introduction of industrial and agricultural technologies;
- emerging and re-emerging infectious disease hazards;
- deforestation, land degradation, and other major ecological changes at local and regional levels; and
- climate change, stratospheric ozone depletion, and transboundary pollution.

The fact that 'traditional' risks still dominate in terms of true health impacts (measured as disability adjusted life years [DALYs], an indicator that accounts for both mortality, morbidity, and productivity loss for various age groups) is borne out by the ranking of diseases as shown in Table 1.

Table 1
Comparing causes of death worldwide with DALYs (1990)

Rank	Top ten causes of DALYs	Top ten causes of death
1	Lower respiratory infections	Ischemic heart disease
2	Diarrhoeal diseases	Cerebrovascular disease
3	Conditions arising during the perinatal period	Lower respiratory infections
4	Unipolar major depression	Diarrhoeal diseases
5	Ischemic heart disease	Conditions arising during the perinatal period
6	Cerebrovascular disease	Chronic obstructive pulmonary disease
7	Tuberculosis	Tuberculosis
8	Measles	Measles
9	Road traffic accidents	Road traffic accidents
10	Congenital anomalies	Trachea, bronchus, and lung cancers

Source. Murray, Lopez 1996.

Women, environment, and health

In addition to environmentalism, the twentieth century has seen the rise of another influential movement, the women's movement. Like environmentalism, this first appeared much earlier, but it was not until the present century, and in particular, until the 1960s, that the women's movement became established as a worldwide influence.

The importance of the role of women was recognized by the United Nations (UN), and 1975 was declared the International Women's Year, to be followed by the UN Decade for Women (UNDW) 1976–85. The end of the Decade for Women was marked by two conferences in Nairobi – a UN conference and a non-governmental organization (NGO) conference. The primary task of the former was to draw conclusions about the experiences and obstacles encountered in the attainment of the goals of the UNDW, and to prepare forward-looking strategies for the advancement of women up to the year 2000.

The Non-Governmental World Conference of Women–Forum 85 was held in parallel to the UN conference. One of the characteristics of the forum was that women were actively involved, and there was constant exchange of views, experiences and opinion, and sharing of research and knowledge. During the course of discussions, the importance of women as daily managers of natural resources and caretakers of the environment became apparent.

Although the main focus of the 1985 conferences was women and development, the linkage between women and environment was not highlighted, and even the Brundtland report makes only brief reference to women. However, the role of women was highlighted in the United Nations Environment Programme (UNEP), State of the Environment Report 1988. The topic has been the focus of discussions in various conferences, seminars, and workshops, especially those in connection with the 1992 UN Conference on Environment and Development (UNCED).

Women's contribution to making the environment as a central issue has been significant. All over the developing world, women play a crucial role in environmental management, as farmers, as stockbreeders, and as suppliers of fuel and water. Women interact most closely with the environment. They are the managers, and often, the preservers of natural resources. The importance of women's role in environmental issues has long been recognized in the developing countries. The empowerment of women is vital if they are to participate fully.

But the close and symbiotic relationship that these women have with the natural world – built up over generations – is breaking down. Recognizing and restoring that healthy relationship is not only crucial for any lasting improvement in women's own development position, but is also fundamental in the move towards sustainable development.

What matters now is how the link between women and environment is perceived and acted upon. Above all, governments, aid agencies, and local communities must see women as central figures in

environmental management; they should be shaping policies and projects and benefiting directly from them. It is not enough to reduce the damaging effects of conventional development; there is a need for positive action to enhance their role of women as resource managers.

Agenda 21 points out that sustainable development can be achieved only if the whole community is adequately represented and participates in decision-making. Additionally, responsibility for preventive health and environment actions must rest with the communities themselves, otherwise such actions may be abandoned or undermined. Representation of women is particularly important since they play the key role in all societies with respect to basic living conditions such as housing conditions, sanitation, provision of safe drinking water, each of which impacts on the environment.

In spite of the widespread movement towards democratization in most countries, women yet remain largely under-represented at most levels of government, especially in ministerial and other executive bodies. They also continue to be prevented from attaining political power in legislative bodies.

Women's representation in politics and essentially in decision-making positions would help redefine political priorities, place new items on the political agenda that reflect and address women's gender specific concerns, values, and experiences, and provide new perspectives on mainstream political issues. As stated in the report of the Fourth World Conference on Women, held in Beijing in 1995 – 'a precautionary approach to environmental hazards should include improved analysis of women's concerns about environment and health, and follow-up action.'

Gender specificity of environmental effects mainly arises from pre-existing gender inequalities in division of labour; the intra-household distribution of subsistence resources; access to productive resources, other assets, income-earning opportunities, and participation in decision-making. The gender analysis of pollution problems indicates three types of situations, which are listed below.

1. Only women and children are exposed to certain pollutants. Examples: occupational exposure in industries (organized or unorganized) where only women are employed, such as electronics, matchbox and fireworks, agate, slate, brick, rag-picking, etc. Clearly, in such situations, women are the sole victims of pollution and therefore their participation in decision-making is more than justified. Since women have a disadvantaged position in the labour market and because of their lower occupational mobility, they are unable to move away from

hazardous environments. The health effects of air pollution due to cooking with low-grade fuels is another example. Fetching of polluted water, bathing or washing clothes in polluted waters are other examples where women get exposed to pollutants.

2. Both men and women are equally exposed to similar levels of pollution, but the weaker physiological status of women and other factors make them more vulnerable to pollution hazards. Such a situation is more common in rural areas and slums. For example, all people living along the roads are exposed to similar levels of pollutants generated from vehicles. But the weaker physiological status of urban poor women makes them succumb to pollution-related illness more easily than their male family members. Here, participation of women is justified on the basis of the fact that they form the bulk of the affected population.
3. Both men and women are exposed to similar levels of pollution and the health outcomes are also similar. This is common in comparatively affluent classes of the population. In such situations, the participation of women is justified because they form approximately half the affected population.

Domestic environment and health

The household environment carries the biggest risks to health for poor people in the less developed regions, especially women. These risks are typically 'traditional' in nature. The World Bank (1993) calculated how much of the total burden of disease could be attributed to household environmental problems including crowding, lack of sanitation, garbage disposal, indoor air pollution, and vector-breeding grounds. The study concluded that 30% of the burden of disease could be averted by improvements in the household environment, of which 20% are modest interventions (Table 2).

The most recent estimates of WHO (1997) indicated that although, virtually all cases have an environmental cause, 90% of the diarrhoeal diseases could be averted through feasible environmental interventions. The WHO study defines environmental contribution as the specific fraction of disease occurrence that could be prevented through 'feasible environmental interventions'. The same study attributes the likely environmental contribution to malaria also at 90%, to ARI at 60%, and to cancer at 25%. In all, environmental factors account for 23% of the global burden of disease. Though the

Table 2

Estimated burden of disease from poor household environments in demographically developing countries, 1990, and potential reduction through improved households

Principal diseases related to poor household environments[a]	Relevant environmental problem	Burden from these diseases in developing countries (millions of DALYs per year)	Reduction achievable through feasible interventions (%)[b]	Burden averted by feasible interventions (millions of DALYs per year)	Burden averted per 1000 population (DALY's per year)
Tuberculosis	Crowding	46	10	5	1.2
Diarrhoea[c]	Sanitation, water supply, hygiene	99	40	40	9.7
Trachoma	Water supply, hygiene	3	30	1	0.3
Tropical cluster[d]	Sanitation, garbage disposal, vector breeding around the home	8	30	2	0.5
Intestinal worms	Sanitation, water supply, hygiene	18	40	7	1.7
Respiratory infections	Indoor air pollution, crowding	119	15	18	4.4
Chronic respiratory diseases	Indoor air pollution	41	15	6	1.5
Respiratory tract cancers	Indoor air pollution	4	10[e]	*	0.1
All the above		338	—	79	19.4

Source. The World Bank 1993.

Notes. The demographically developing group consists of the demographic regions of Sub-Saharan Africa, India, China, other Asian Islands, Latin America and the Caribbean, and the Middle Eastern Crescent.

* Less than 1; [a] The diseases listed are those for which there is substantial evidence of a relationship with the household environment. Examples of excluded conditions are violence related to crowding (because of lack of evidence) and guinea worm infection related to poor water supply; [b] Estimates derived from the product of efficacy of the interventions and the proportion for the burden of disease that occurs among the exposed. The efficacy estimates assume the implementation of improvements in sanitation, water supply, hygiene, drainage, garbage disposal, indoor air pollution, and crowding of the kind being made in poor communities in developing countries; [c] Includes diarrhoea, dysentery, cholera, and typhoid; [d] Diseases within the tropical cluster most effected by the domestic environment are Schistosomiasis, South American trypanosomiasis, and Bancroftian filariasis; [e] Based on very inadequate data on efficacy.

term 'environment' includes ambient and occupational factors, it is clear that the domestic environment is a major contributor to this burden.

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Housing

Review of policy and research trends

An assessment of the linkage between housing factors and the health of women and children in the developing world, initiated by the United Nations Environment Programme (UNEP), is summarized in this chapter. It also reviews the state of knowledge and contemporary situation, both scientific and policy literature, and presents an analysis of the current and future research issues and policy options in the area.

Colonial construction of the housing–health linkage

The linkage between housing and human health has been outlined in 'modern' scientific and health literature for well over a century-and-a-half. The early articulation of causal relationships, exposure

pathways, and 'risk factors' largely focused on the linkage between physical attributes of housing (e.g., construction materials, crowding), environmental service provision (e.g., handpump water supply), and communicable diseases (e.g., tuberculosis, cholera). These were first posited in relation to inadequate living conditions in industrial towns and urban slums, and later to the underdeveloped rural areas of 'industrial' countries.

The colonial period saw a postulated linkage in the mainstream public health literature among the poor quality of built environment, inadequate personal and public hygiene of 'natives', and their endemic state of disease (Oldenburg 1989). Much of the public health and planning interventions in former 'colonies' was informed by this world view, in spite of the long historical linkage between traditional health practices, settlement planning, and housing in these cultures. Nevertheless, little emphasis was laid on the specific problems of women and children.

Watershed I: post-war softening of focus

In the post-war period, along with further developments of 'modern' medicine and the initiation of a 'war' to eradicate specific communicable diseases, the articulation of housing–health linkage in 'industrial' and subsequently in developing countries (DCs) changed slowly, but significantly. The exclusive emphasis on physical factors and technical interventions in response to this challenge weakened. For the first time, socio-economic, environmental, and psycho-social factors were acknowledged as intermediary factors that influenced the housing–health linkage.

Policy articulation – research gap

Systematic scientific studies that concretely established the relationship between improved housing conditions and health in DCs were few and far between. This 'gap' between problem articulation in the public policy domain and scientific research was influenced by many factors. The most important factor, the housing–health linkage, was accepted as 'common sense' by medical, planning, and scientific professionals who were responsible for knowledge creation. Hence, research to establish such a causal chain appeared unnecessary. Policy-makers of newly-independent states, where rural and urban reconstruction and large housing development projects were the order of the day, used public health considerations as a basis to argue for increased sectoral investments.

Simultaneously, the international medical and research community was occupied with more important concerns. Research into 'peripheral' questions in an age when the 'eradication' of many communicable diseases seemed achievable, was given relatively low priority. The propagation of a 'universal' model of disease and medical intervention, with limited experience of the complex socio-economic factors and strong access differentials in DCs, and their significant impact on exposure and risk levels of vulnerable groups, severely constrained structured enquiry. In short, in spite of the fairly clear problem of articulation and policy prescriptions in this area, little quality research was undertaken on DC problems.

Watershed II: Stockholm and Vancouver

Within the international policy domain, the Stockholm Environment Conference (1972) and Habitat I at Vancouver (1976) were turning points in the articulation of the relationship between the built environment, human health, and well-being. A parallel World Health Organization (WHO) initiative, concreting housing–health linkage (starting in the 1960s) dominated the sectoral policy agenda for nearly a decade-and-a-half. For the first time, an integrated approach that attempted to link changes in the built environment with human health and well-being (especially of vulnerable groups) began to take form.

WHO expert committee reports: an early start lost?

A series of WHO surveys and expert reports in the early 1970s laid a solid foundation for enquiry into housing and health in DCs. It was unfortunate that this early start was lost for almost 15 years, before being resurrected in the '80s. Independent researchers and non-governmental organizations (NGOs) working on the human environment spurred a renewed international policy and research interest in this enquiry (Satterthwaite et al. 1990).

The Expert Committee on Public Health Aspects of Housing (WHO 1961) outlined the key gaps in research including human physiological requirements (related to microclimate), epidemiology of the impact of housing on disease incidence, and housing-induced family and social problems. The main recommendations included: provision of safe and potable water to each household in DCs; greater attention to accident prevention; and planning and preparation of

Housing Codes in view of the relationship between housing and health. The Expert Committee on Environmental Health Aspects of Metropolitan Planning (WHO 1965) drew attention to the rapid deterioration in the urban environment especially due to inadequate quality of water supply, inefficient waste disposal and drainage, lack of open space in cities, and also pointed out the need to control urban vectors.

The survey of Health Hazards of the Human Environment (WHO 1972) reviewed the home environment in DCs, and recommended improvements in housing for the poor, reducing overcrowding, increasing living space, and the provision of basic sanitation facilities. In connection to the above, housing standards, home accidents, sanitation technology, chemical contamination, and surveillance and monitoring were also discussed.

Two years later, an Expert Committee on the use of epidemiology in Housing Programmes and Planning Human Settlements (WHO 1974 a) reviewed the state of knowledge in the field. The effects of physical factors including climate, special housing problems in DCs, building materials and new construction methods were examined, and a research gap on psycho-sociological aspects of well-being identified. Suggestions were also made for establishing suitable guidelines for healthy housing. Another Expert Committee Report on Disposal of Community Waste Water (WHO 1974 b), examined the effects of waste water on public health, and cultural and socio-economic conditions. Particular importance was given to the problems in urban fringe areas emphasizing waste water collection and disposal facilities during settlement planning and coordination between land-use planning, and urban services provision.

An annotated bibliography on housing, housing environment (Martin et al. 1976), and health was produced in the same year. A year later, a monograph on Promoting Health in the Human Environment (WHO 1975) presented a broad definition of the human environment encompassing not only physical, but also psycho-social elements. Emphasis was laid on citizen participation for improving built environment and health.

Watershed III: healthy principles of housing or the 'Poor Die Young'

After a gap of nearly 15 years, a monograph on Healthy Principles of Housing (WHO 1989) laid out 11 basic principles governing the relationship between housing, environment, and health of inhabitants.

Suggested interventions included advocacy for cognizance of the health value of adequate housing, changes in economic and social policies, improved norms for house design and construction, and alliance-building between community organizations and external agencies to upgrade houses.

In parallel, problem articulation by housing and environmental researchers and practitioners led to a resurgence of interest in the sector, especially in the deterioration of urban environmental quality. These initiatives, however, continued to be dominated by the 'developed' countries, by often tilting research agenda and programming interventions towards their concerns (Satterthwaite et al. 1990). The identification of women and children as an especially vulnerable high-risk group began to emerge.

A changing research agenda

Simultaneously, the articulation of a range of health risks ranging from childhood diarrhoea to a resurgence of drug-resistant forms of malaria led to intensive scientific enquiry into a range of previously under-researched questions. An indication of the strength of this change in research focus comes from a comparison of seminal reviews of diarrhoeal diseases in the mid 1970s (Saunders, Warford 1976) which was almost exclusively drawn from Western sources, and that of the mid-1980s (Esrey, Habicht 1986) that drew on a large number of DC studies.

Gender and child-centred concerns

The recognition of 'gender' (starting in the 1970s) and child-centred concerns (in the late 1980s) as a legitimate and critical input to health in DCs brought together a new range of questions. This further 'confounded' an already complex domain between health and housing, public policy, and social and medical sciences. The voice of practitioners from DCs speaking to a policy audience, in search of new 'problems' and 'solutions' became important in articulating the differential burden, exposure, and risk of women and children in the domestic environment. The absorption of this perspective into research priorities, funding, and publications appears to be another matter.

Watershed IV: Rio and beyond

The Earth Summit (1992) focused on the policy debate on achieving 'sustainable development' by meeting the needs of the present (and

future) generation through improving the health and well-being of the environment on which they depend. Subsequently, a series of follow-up policy documents attempted to demonstrate that environmental quality is crucial for human health at the macrolevel (UNCHS 1996, WHO 1997). This was separate from a diverse set of meso and microlevel Agenda 21 initiatives focusing on sustainable cities and environmental health.

The PSIR framework: simple to communicate but inadequate to intervene

The mainstream sustainable development (and environment) community has recently chosen to propagate a relatively simple 'cause-effect' framework to derive the effect of certain driving forces (via Pressure–State–Impact–Response [PSIR] exposure pathways) on environment and human well-being (OECD 1993, UNCSD 1996, Briggs et al. 1996). Though relatively easy to communicate, this framework may be inadequate to scientifically describe the significant interactions, and hence possible interventions required in the confounded health–housing–environment landscape.

The PSIR framework has been picked up by recent health policy documents (WHO 1997) attempting to cross-discipline barriers at some loss to the explicit cognizance of the complexity of the problem at hand. Environmental threats have been classified within this framework into 'traditional' hazards which are often associated with underdevelopment and 'modern' hazards associated with or overdevelopment. Traditional hazards, thus defined, are closely allied to poverty, inadequate working and living conditions, and are thereby closely linked to the domestic built environment. These hazards include: lack of access to safe drinking water, inadequate sanitation and solid waste disposal facilities, exposure to disease vectors, indoor air pollution, contaminated food, and risk of injury.

Modern hazards are seen as an outcome of the impact of industrialization and/or urbanization on land, water, and air. These hazards include solid and hazardous waste accumulation, chemical and radiation hazards, and emerging diseases caused by unsustainable ecological changes. These are often more commonly reported in the developed world, but with rapid urbanization and uncontrolled industrial development, the incidence of modern hazards is expected to increase in DCs as well.

Linkage gap between macrodriving forces and microdynamics

The United Nations Commission for Sustainable Development (UNCSD) has identified five sets of driving forces that affect the health and welfare of current and future generations. They are population growth and urbanization, poverty and inequity, technological development, economic development, and consumption patterns. There is clearly an impact on the domestic environment by all the five driving forces, but probably most strongly by economic and social development and urbanization. The linkage between these macroforces and microdynamics that define differential exposure and vulnerability with the DC domestic environment are few and far between.

Does better housing lead to improved health?

The relationship between human health and environment is highly complex, with multiple interacting pathways and non-linear relationships between exposure and health effects. The health community has consistently maintained the existence of these complex relationships, but pragmatically focused on strategies and interventions which can effectively disrupt or modify these pathways, without necessary understanding of their subtleties. Community health, epidemiology, housing, and social sciences investigation of this domain has examined the socio-economic, behavioural, and spatial dimensions of these relationships. These disciplines have been reticent to put forth a 'generalizable' model, given the diversity of contexts and in various parts of the world. This has been both a strength and a weakness, as a strong articulation from the scientific community would enable clearer policy definition and programme design.

In short, in both policy and research, five areas of enquiry have helped set the agenda on the housing–health linkage over the last two decades: health, housing, environment, gender studies, and child health. The health–housing–environment linkage has been broadly established in the scientific literature of industrialized nations. The literature in this area in DCs is still weak, yet it could enable the definition of the broad contours of a future plan of action.

The most serious research gap is on the specific question of differential impact on women and children. It is still unclear whether this is because of the absence of data or lack of impact. Field and circumstantial evidence suggests that inadequate enquiry and a severe data gap lies at the heart of this problem.

A sound built environment as a support to health

A slow shift appears to be taking hold in the environmental domain, from an almost exclusive focus on the adverse health effects of environmental hazards to a more positive approach as to how a sound environment can support or 'enable' health. Within this, the built environment and more specifically, the domestic environment is now being recognized to have a significant role, as it is often the primary locus of activity in DCs. This may be specially important for women and children who spend most of their time in the domestic environment, and hence are exposed differentially (to most men) to environmental hazards within their homes.

Differential vulnerability and its impact on women and children

The provision of environmental infrastructure in both rural and urban areas has clearly been slower than the staggering population growth of many DCs. Increasing disparities of real incomes, subsidies to the rich, and the physical displacement of vulnerable communities has led to a situation where poverty and declining environmental quality are becoming even more closely linked.

Access to improved housing and environmental services for those living in absolute poverty including the high proportion of women and children is still unacceptably low (WHO 1996). The health risks from inadequate housing, water and sanitation (W&S), and injury and disaster are increasing for the poorest and the most vulnerable population groups including women-headed households and children (UNCHS 1996).

A number of environmental, social science, and policy studies show that being a child or a female is often a precondition for deprivation, neglect, and reduced access to essential resources. Local and domestic environmental conditions affect women more than any other group (WHO 1997) followed by children. With declining environmental conditions, the workload on children, especially girl children, rises (UNDP 1995).

In spite of women being the primary managers of environmental resources, their lack of influence and decision-making power, both within the family and the community in most DCs, means that long-term concerns and priorities are competed by short-term 'male' interests. In addition, women usually perform multiple roles in the household: reproductive, productive, and community management,

often with considerable risk exposure. This combination of long duration work and high intensity of exposure to health risks has significant long-term impacts on women and children (Stephens et al. 1994, Sims 1994).

Due to the complex interaction of factors that lead to these health effects, interventions need to be made in various areas including technological, socio-economic, ecological, policy, and regulatory. These would not only demand inter-sectoral cooperation but also cooperation between the community and the household sectors, and the government and the private agencies.

Methodology

The key research and methodological concerns that this chapter is attempting to address are presented in the following sections. Based on preliminary findings of this study and peer review, the primary research questions were modified, and analysis undertaken on that basis.

The initial research question

The initial research question addressed was: *Does the published scientific and policy literature indicate an impact of housing (as separate from water supply, sanitation, and indoor air pollution) on the health of women and children in the developing world?*

Insufficient scientific data to account for policy conclusion

The policy literature, true to the analysis of past trends, appears to answer the research question strongly in the affirmative. A review of the recent policy literature (World Bank 1993, WHO 1996, WHO 1997, UNCHS 1996) suggests a strong differential impact of housing on the health of women and children in DCs.

This, however, is not clearly borne out by a review of the sparse scientific literature in this area. Estimates of the global burden of disease indicate that women (for many regions of the world) are exposed to higher health risks from communicable diseases, which in turn can be postulated to account for the bulk of housing-related health risks. However, due to confounding aggregation of data and a

number of assumptions made in estimating the health burden, it becomes difficult to clearly establish this trend.

Possible causes of the data gap

The 'gap' in the problem statement between the policy domain and scientific literature is a serious one. A few possible reasons are listed below.

1. Policy literature has come to this conclusion based on limited, confounding, or erroneous scientific data. The overall data set on which much of the policy analysis has been anticipated (e.g., studies on diarrhoeal disease) may not take into account the complex factors limiting the impact of domestic environment on health, and the special place of women and children within it.
2. Housing-related exposure pathways cannot be scientifically researched within the current framework of enquiry, and would require significant inter-disciplinary inputs to deal with a wide range of confounding socio-economic, behavioural, and technological factors.
3. There is an indeterminate impact of housing on human health in the DCs. It may be because this is a nascent area of enquiry, especially in relation to the diverse prevailing patterns of traditional housing; lifestyles; and hygiene, beliefs, and practices within the domestic environment in the DCs.
4. There are indeterminate (or no) differential impacts of housing on the health of women and children in the DCs.
5. There are stronger causal linkages between health and other organizing principles (e.g., poverty, malnutrition or hygiene behaviour) than housing.

Too narrow a definition of housing

The most obvious implication of these hypotheses is that the commonly understood definition of 'housing' is too rigid, especially when it excludes water supply and sanitation. This constrains housing interventions to changes in the physical structure of the domestic environment.

There is now worldwide acceptance especially after Habitat I and II conferences that housing is more than 'four walls and a roof'. Housing is now a fundamental developmental process in which the built environment is created, used, and maintained. In its simplest form, it includes 'the immediate environment and amenities' and

'environmental services' (WHO 1974 a, UNCHS 1996). The problem with most policy documents and health literature is that housing is rarely recognized as a process of transformation of the built environment. It is most often seen as a physical product. Crucial housing questions (e.g., location and siting which directly influence vector concentration and hence the risk of communicable diseases) are often not considered 'serious'.

Limited research on housing and health

Published research on housing and health from DCs is limited. Further, gender and age-cohort disaggregated research is even less frequent (less than 0.5% of reviewed literature). The bulk of medical and scientific literature appears to be 'conservative' in its approach to socio-economic, gender, and environment-driven problems; as indicated by the fact that age, gender or socio-economic class dissagregated data is rarely reported, and almost never in combination.

There appears to be a determinate impact of housing on human health in the DCs. This is certainly confounded by socio-economic, nutritional, behavioural, and technological factors. Since the health and scientific literature rarely reports differential vulnerability and exposure of women and children, it is difficult to determine whether this is due to lack of data or lack of causal linkage.

Lack of cognizance of housing processes in DCs

A fundamental difference exists between housing processes in the 'developed' and 'developing' world. A number of key DC processes and trends will have to be recognized before the linkage between housing and health can be investigated effectively. These include the following.

1. The bulk of housing in DCs is built of biomass, earth, tile, recycled, and other non-permanent material. This trend is expected to continue well into the next century, unlike in industrialized countries where 'permanent' building materials and industrial production and building standards are the norm. This has strong influence on the disease and vector transmission pathways and risks.
2. Most houses in DCs are built by households themselves with help from artisan labour or petty contractors with little access to industrial technologies and specifications that are used in high-quality permanent buildings in the developed world. This

constrains the use of industrial building technologies and technical interventions in DCs to deal with Chagas disease or even malaria and filariasis.

3. Upgradation of building roof and wall materials and the addition of floor area through new rooms are probably as important as a new house construction in DCs, as households have to cope within limited budgets and the continually rising prices of industrial building materials. Hence, radical measures to transform the built environment will have to be slowly phased, in consonance with residents' affordability and priorities.
4. Insecurity of tenure and the speculative operation of commercial land markets have increasingly pushed the poor and disadvantaged into hazardous sites. This is a significant additional health risk factor for diseases like malaria and dengue, especially in rapidly expanding urban areas in the DCs.
5. Centralized infrastructure provision (e.g., piped water and sewerage) in both urban and rural areas are the exception rather than the rule in DCs, and will probably continue to be so. This is one of the underlying factors that constrains the rapid decline in morbidity and mortality of water-related diseases.
6. Formal housing standards which are clearly linked to improvements in health conditions though the construction of environmental health barriers or the provision of basic urban services may work for the 'rich' in DCs but are usually unaffordable by the poor, who are generally the population at risk. Vector control programmes will have to be better-linked to the housing process if they have to succeed.
7. Most housing processes are controlled by men except for key environmental management and maintenance tasks that women take care of. In contrast, the exposure levels to domestic environmental risk are higher for women in DCs. Public programmes of community-based intervention, health care, and even chemotherapy which does not take cognizance of the asymmetric role of women in the decision-making domain, quickly get bogged down.
8. The domestic environment is the locus of both reproductive and productive work for most women in the developing world whether be in rural or in urban areas. In fact, a large proportion of community management processes, especially of environmental services and infrastructure also takes place in the extended domestic environment (Moser, Linda 1987). Increasing the space,

role, and power of women in decision-making on the design forms and investment of the built environment are crucial, but often come up against strong local and sociocultural barriers.

Redefining the research questions

A redefinition of the research agenda to accommodate these ground realities into research design and practice seem necessary if serious interventions to reduce the role of domestic environment in human ill health in DCs have to be made. New research and programme delivery methods will be required to meet the needs of gender sensitivity and child-centredness.

Based on the above analysis, the broadly restructured key research questions are listed below.

1. What are the key exposure pathways that link housing processes (as broadly defined) in the developing world with human health as published in the scientific, technical, and policy literature?
2. Are women and/or children differentially exposed within the above context to health risks. If so, how, and how can this be assessed?
3. Are women and/or children differentially vulnerable within the above context to health risks? If so, how, and how can this be assessed?
4. Have successful interventions/instruments been used to reduce exposure and/or vulnerability? If so, how effective have they been?

Policy and scientific literature review

The methodology applied to address the above four research questions has been explained along with the key sources for scientific, technical, and policy data for this review.

The first activity undertaken was a review of key policy documents and regional housing and health trends in the developing world. The key sources were the WHO, Pan American Health Organization (PAHO), United Nations Childrens Fund (UNICEF), United Nations Development Programme (UNDP), United Nations Centre for Human Settlements (UNCHS), World Bank, Centre of Disease Control (CDC), and National Institute of Health (NIH) (US Government sites). This leads to the identification of the key issues and an order of magnitude estimation of the burden of disease (regionally and by disease).

A review of policy and scientific documents was undertaken using an online bibliographic search of key resources including the WHO, National Medical Library (NML), NIH, CDC, Library of Congress,

Indian Scientific Documentation Centre (INSDOC), and allied libraries. Select holdings of the International Institute of Environment and Development (IIED), UK were also reviewed. An important source of information from the pre-1974 period was the WHO annotated bibliography on housing, the housing environment, and health (Martin et al. 1976).

Global burden of housing-related diseases

The key causes of deaths across the world related to housing include: acute respiratory infections (ARI) (8.1%), tuberculosis (5.2%), accidental injuries (5.7%), and malaria (3.9%) (Murray, Lopez 1996 b).

Burden of disease

Global estimates of years of lives lost (YLL) and disease adjusted life years (DALYs) are presented in Tables 1 and 2. The maximum

Table 1
Global burden of disease and injury attributable to selected risk factors, 1990

Risk factor	Deaths ('000)	As% of total deaths	YLLs ('000)	As% of total YLLs	YLDs ('000)	As% of total YLDs	DALYs ('000)	As% of total DALYs
Malnutrition	5881	11.7	119486	22.0	20089	4.2	219575	15.9
Poor water supply, sanitation and personal and domestic hygiene	2668	5.3	85520	9.4	7872	1.7	93392	6.8
Unsafe sex	1095	2.2	27602	3.0	21100	4.5	48702	3.5
Tobacco	3038	6.0	26217	2.9	9965	2.1	36182	2.6
Alcohol	774	1.5	19287	2.1	28400	6.0	47687	3.5
Occupation	1129	2.2	22493	2.5	15394	3.3	37887	2.7
Hypertension	2918	5.8	17665	1.9	1411	0.3	19076	1.4
Physical inactivity	1991	3.9	11353	1.3	2300	0.5	13563	1.0
Illicit drugs	100	0.2	2634	0.3	5834	1.2	8467	0.6
Air pollution	568	1.1	5625	0.6	1630	0.3	7254	0.5

Source. Murray, Lopez 1996.

Table 2

Burden of disease linked to housing conditions in females by cause and region, 1990 (hundreds of thousands of DALYs lost)

Disease or injury	SSA	IND	CHN	OAI	LAC	MEC	FSE	EME	FSE & EME	DDG	World
Diarrhoeal diseases	146.2	143.9	21.7	68.8	27.6	78.9	1.1	1.2	2.2	487.2	489.4
Malaria	154.1	4.7	—	12.5	2.2	1.5	—	—	—	175.0	175.0
Chagas disease	—	—	—	—	12.6	—	—	—	—	12.6	12.6
Lymphatic filariasis	0.5	1.6	0.4	0.3	—	0.1	—	—	—	2.9	2.9
Intestinal helminths	4.3	10.0	30.6	28.5	11.9	2.6	—	—	—	87.9	87.9
Ascaris	2.2	5.7	18.7	15.7	6.7	2.4	—	—	—	51.4	51.4
Trichuris	1.5	2.4	10.9	11.6	4.5	—	—	—	—	30.9	30.9
Hookworm	0.5	1.9	0.9	1.2	0.7	0.2	—	—	—	5.6	5.6
Upper respiratory infections	1.7	2.8	2.7	2.3	1.3	0.4	1.0	2.3	3.3	11.1	14.4
Asthma	10.0	8.7	17.1	7.0	5.6	4.9	2.7	5.8	8.4	53.2	61.7
Falls	9.5	21.1	19.2	7.3	2.7	4.6	2.8	7.4	10.2	64.4	74.6
Fires	4.2	8.5	5.6	2.9	1.9	2.6	1.1	1.9	3.1	25.7	28.8
Drowning	4.2	8.3	16.6	3.0	1.1	2.6	0.8	0.5	1.4	35.7	37.1

SSA–Sub-Saharan-Africa; IND–India; CHN–China; OAI–Other Asian Islands; LAC–Latin America and Caribbean; MEC–Middle Eastern Crescent; FSE–Formerly Socialist Economies; EME–Established Market Economies; DDG–Demographically Developing Group

Source. World Bank 1993.

proportion of DALYs attributed to housing-related diseases are ARI (8.5%), diarrhoeal diseases (7.2%), tuberculosis (2.8%), malaria (2.3%), and accidental injury (11%) which totals to almost 30% (World Bank 1993). Only a fraction of this total burden will be directly attributable to housing and related linkages, till detailed disaggregated data is available and research gaps closed.

The pattern of disease burden (DALYs) among children is presented in Table 3. Here again the proportion of both deaths and DALYs attributed to domestic environment are high (World Bank 1993).

Vector-borne diseases

Housing is shown to be critical to the survival of various disease-carrying vectors. These vectors are mostly prevalent in the poorest areas of DCs with people in highly impoverished living conditions. The most important among these are insect vectors of malaria, Chagas disease, dengue, and filariasis.

The largest population at risk due to malaria is 2.02 billion, within which 0.5 billion are infected, with 1.5 to 2.7 million deaths

Table 3
Distribution of the disease burden related to housing condition in children in developing economies, 1990

Total DALYs lost (million)	Children under five				Children aged 5–14 years			
	female 250		male 268		female 67		male 75	
Disease and injuries	rank	per cent	rank	per cent	rank	per cent	rank	per cent
Diarrhoeal diseases	3	16.2	3	15.7	4	7.1	4	6.1
Malaria	6	4.7	6	4.7	6	4.9	6	4.3
Intestinal helminths		—		—	1	12.3	1	11.4
Respiratory infections	1	18.5	2	17.6	3	7.9	3	6.9
Asthma		0.2		0.2		2.3		2.6
Falls	10	1.2		1.0		1.9	10	3.1
Drowning		0.6		0.7		1.7	9	3.2

Source. World Bank 1993.

reported annually. This is followed by intestinal parasites which are the most endemic group of vector-borne diseases with over 4 billion people at risk, within which 3.5 billion are infected, and nearly 0.25 million related deaths every year.

Schistosomiasis infects over 2 million people, with a population of 600 million at risk and mortality of about 20 000 a year. Filariasis exposes close to 1.1 billion people to risk with 120 million infected, and over 40 million with chronic disability. Dengue and dengue haemorrhage fever are estimated to kill 20 000 to 30 000 people per year; in fact, over 10 million are infected with 2.5 to 3 billion at risk. Chagas disease infects about 18 million people, kills nearly 50 000 a year, and about 100 million are at risk.

Diarrhoeal diseases

Diarrhoeal diseases are closely related to poor sanitation and hygiene, and affect children and elderly the most. An estimated 90% of the diarrhoeal disease burden is linked to environmental factors of poor sanitation, access to clean water, and contaminated food which are directly linked to the domestic environment (Murray, Lopez 1996 a).

A cholera epidemic in Peru in 1991 not only caused 2600 deaths and over 320 000 cases, but an estimated US $1 billion economic loss which was substantially less than the capital required to radically

improve the W&S conditions in Peru settlements (World Bank 1992). It also marked the return of a disease which had been assumed to be eliminated from the region by improvements in the domestic and urban environment.

Improvement in water quantity and excreta disposal facilities have been shown to be more important than improvement in water quality (Esrey et al. 1985) which has been slightly modified in a later review (Esrey et al. 1991). A more recent review has demonstrated that improvement in sanitation had greater impact on diarrhoeal prevalence than improvements in water (Esrey 1996). Nevertheless, these interventions cannot be made in isolation and have to be linked to larger socio-economic processes to sustain improved domestic living conditions.

Households without easy access to piped water were 4.8 times more likely to die of diarrhoea than those with piped water in their homes. Those with piped water to their plot but not to their house were 1.5 times more likely to die of diarrhoea in metropolitan areas of South Brazil.

Housing-related health risks

The WHO has defined nine features of the housing environment that have direct or indirect health impact (WHO 1989). These include the physical structure of the built environment; provision of adequate water supply; disposal of faeces, liquid and solid waste; quality of the housing site; overcrowding; indoor air pollution; food, safety, and occupational health in the domestic work place; and disease vectors.

In DCs, the most important housing-related risk factors fall into communicable disease and accidental injury categories. The health burden for communicable diseases has been shown to decline considerably when a high proportion of the population lives in good quality housing and has ready access to health care services (UNCHS 1996).

Women's higher exposure level in the domestic environment

The levels of exposure to health risks in the domestic environment vary. However, women are more likely to be exposed to health hazards in their homes since they spend more time within the domestic

environment undertaking certain activities (e.g., cooking) which increases the risk of differential exposure. Inadequate nutrition, domestic hygiene, and the extra burden of making up for the inadequate provision of basic services (e.g., water) may significantly increase women's workload and thereby take its toll, due to lower body resistance (WHO 1997).

Women physically have a higher disease burden than men for infectious and parasitic diseases in most regions of the world (except Latin America, the Caribbean, and sub-Saharan Africa).

Lack of data on domestic environmental quality

Though physical housing conditions are documented across much of the world; little information is available on the quality of the built environment except for a broad classification of house types, the provision of environmental infrastructure, and occasionally, the levels of crowding.

A relationship between high levels of crowding and increased health risks is widely reported in the literature but little scientific evidence is available on the clear cause-effect relationship in DCs. The impact of crowding on psychological distress in women and children has been reported by practitioners, but is not clearly established in the scientific literature except for a few limited studies that show that building microclimate and high domestic noise levels lead to psychological stress and sleep disruption.

The incidence of tuberculosis (the single largest source of premature death among adults worldwide) is also linked to overcrowded conditions in both rural and urban areas. The highest incidence tends to be among population living in the poorest area with high levels of overcrowding and high number of social contacts (WHO 1992). In low-income areas, in cities, a combination of overcrowded conditions along with poor ventilation often means that tuberculosis is transmitted to more than half the family members (Cauthen et al. 1988).

Chagas disease is closely associated with the quality of housing as it is transmitted by insects that live in mud- or in timber-walled houses. This disease affects nearly 18 million people in Latin America (WHO 1997). Damp houses may be a contributory factor to various respiratory illnesses and arthritis as well as a medium for promoting the propagation of insect, bacterial, or viral agents (WHO 1988 a, Hunt 1993). Some building materials contain hazardous substances such as asbestos and radon, the impact of which is hardly studied in DCs.

Domestic accidents and the home environment

Poor quality housing and crowding are reported to increase the risk of household accidents which include falls, burns, cuts, and poisoning. The kitchen is a common place for these accidents to take place. Home accidents are reported to be a major cause of early childhood and elderly deaths in the developed world (Boucher 1995, Mood 1993), but no comparative study has been undertaken in the developing world.

An analysis of accidents in children, in 10 nations in the South revealed that accidents were the main cause of deaths for 5–9 and 10–14 years old (Manciaux, Romer 1986). For every accidental death, there are several hundred accidental injuries.

In short, the relationship between the quality of housing and the built environment and health has been broadly established. However, specific disease or risk linkages based on risk factors are less well-defined as is differential exposure and risk to women and children.

Risk factors in the built environment

An immense variety of house types and built forms are prevalent across the developing world (OUP 1997). Hence, it is difficult to generalize about risk factors in the built environment. These factors are linked not only to the built form and type, peri-domestic environment, and the lifestyle of people, but also to the behaviour of disease vectors in a particular environment.

Components of the built environment

Nevertheless, a broad analysis of the built environment by building system and services gives us a rough and ready method to identify the key areas for intervention. A building can broadly be classified into six building systems: (i) foundation and plinth, (ii) walls and super structure, (iii) roof substructure and cladding, (iv) floors (both ground and intermediate), (v) openings, and (vi) finishes. The peri-domestic environment will include courtyards, animal pens, and semi-public and public spaces adjoining the house. Key services are mainly water supply and storage, washing, sanitation/sewerage, surface and waste water drainage, solid waste disposal, and cooking.

Key risk factors in the built environment

Based on these elements, the 10 key risk areas by building system, space, and service are presented below.

1. Inadequate foundations and plinth which do not provide protection against dampness, water ingress, and the ingress of borers and pests that can enter through the foundation and walls.
2. Walls made of materials, such as untreated thatch, bamboo, timber, wattle and daub, and earth often provide fertile areas for the propagation of vectors like mosquitoes and triatomine insects.
3. The roof substructure and cladding, especially that of thatch buildings provide an effective space for the resting of insects and their propagation. A large number of insects enter the house through gaps between the walls and through pitched roofs, especially when there are no false ceilings. Inadequate roof overhangs enable damage to walls in the rain thereby promoting the entry of various vectors.
4. Inadequate window and door shutters or openings allow the entry of crawling insects and also, if not screened, mosquitoes and other airborne vectors.
5. Earthen flooring and other non-permanent floors promote the ingress of worms and other geo-helminthic vectors.
6. Inadequate solid waste disposal provides an effective breeding ground for a wide range of mosquitoes, flies, and insects.
7. Inadequate water supply and storage arrangements promote not only the transmission of diarrhoeal disease but also the breeding of mosquitoes and other vectors.
8. Inadequate sanitation facilities enable faecal–oral contamination, diarrhoeal disease, helminthic infections, especially if coupled with inadequate floor materials and water supply.
9. The presence of domestic animals within the built environment, promotes the transmission of zoonoses.
10. Inadequate storage of cooked or unprocessed food provides an opportunity for food-related diarrhoeal disease or infections apart from attracting rodents and other pests which act as a disease vectors.

Mitigating risk in the built environment

The most important risk mitigation strategies in the built environment include proper siting, upgradation of building materials,

modification of the domestic environment to restrict vector propagation and exposure, and establishment of effective environmental services and environmental health barriers. Many interventions can be enabled at relatively low cost including screening of openings, adequate solid waste management, and water supply and storage arrangements. Others, especially the upgradation of building materials and systems, provision of environmental infrastructure, and re-siting buildings can be significantly more expensive. A balanced and incremental set of interventions that are in consonance with the economic capacity of households will be critical to the success of reduced health risk.

Exposure factors

The primary exposure factors in the domestic environment are household wastes – liquid waste (from cooking, washing, and faeces), solid waste (from food, sweepings, and households residues), gases (from cooking and heating), and soil.

Faeces

The most important domestic risk factor is the 1.1 million tonnes of human faeces generated across the walls, of which 45% is produced in the urban areas and the rest in rural areas (WHO 1997). The bulk of this potentially biodegradable material is disposed with little or no treatment, exposing human populations to a wide range of health risks. Only 10% of the DC population has access to sewerage systems (largely in urban areas) and about 20% has some form of on-site sanitation. The rest of the population does not have access to sanitation, placing them at high risk to faecal exposure.

Much of the faeces from populations unserved by sanitation facilities (2.9 billion) is recycled for agricultural use or deposited on land without the destruction of pathogens. These pathogens enter the soil and water sources and contaminate surface or groundwaters (WHO 1997). On-site sanitation does protect individual households since leaching into surface and groundwater is increasingly reported. In addition, the waste from on-site sanitation is often found to contaminate surface and groundwater and often solid waste management systems (Feachem et al. 1983 a). The flushing of excreta into water carriage sewerage systems causes major health hazards when

it is discharged directly or partially treated into local surface waters, rivers, or the sea.

Waste water

Waste water, especially faecal contaminated water poses a high health risk across many DCs through both direct ingestion and contact and indirect contamination.

The most direct effect of improved domestic environment has been reported through better W&S services (Esrey et al. 1991). The primary water-related diseases are malaria (inadequate urban development, poor water management, deforestation, and intensification of irrigated agriculture); schistosomiasis (via infestation increased by irrigation and man-made reservoirs); dengue fever (via inadequate drainage, freshwater storage, and solid waste management); filariasis (via vector breeding in polluted water); and encephalitis (via changes in cropping pattern and agricultural practices). Water-related, vector-borne diseases account for the death of over a million a year, and more than 200 million are affected by them (WHO 1997).

The projected reduction in morbidity due to improved W&S ranges from 80% to 100% in the case of cholera and typhoid, 60% to 70% for trachoma, conjunctivitis, and schistosomiasis, and 40% to 50% for diarrhoeal diseases, ascariasis, and skin infections.

The number of people without access to safe water dropped from about 1.6 to 1.1 billion over the 1990–94 period (UNICEF 1996) because of massive efforts taken by the governments and aid programmes. The bulk of the unserved population (over 0.8 billion) live in rural areas. Water availability in sufficient quantity is the primary risk-mitigating intervention for this population, with improvements in water quality having an important but secondary emphasis. Water quality is closely linked to the type of water source used and the socio-economic status of households and the neighbourhood.

Solid waste

The health risk of solid waste is highest in unserved areas of dense urban concentrations which are rapidly proliferated in DCs. In many rural areas, the problem is still not acute. In cities, a wide range of population groups are at risk due to secondary impacts such as the proliferation of disease vectors, sharp objects, and

surface and groundwater contamination caused by inadequate solid waste management.

Food contamination

Food contamination is one of the most important causes of diarrhoeal disease via bacterial, viral or helminthic infections. This is directly related to factors within the domestic environment (e.g., dirty hands, flies and pests, domestic animals, dirty cooking vessels, and contamination from human and animal faeces).

Air pollution

Indoor air pollution from cooking and space heating is a significant risk factor in most DCs. This has shown to have a clear differential impact on women and children whose exposure levels are high in the domestic environment.

Soil contamination

Soil-related hazards are very common in the domestic environment where floors are made of earth and children play in the dirt. Geo-helminthic infestation is the most widely-reported malady in the DCs.

Exposure reduction

Given that both women and children will continue to spend the bulk of their time within the domestic environment in DCs in the foreseeable future, exposure reduction interventions will be critical to mitigate health risks. The mix of hazards will be quite different based on the location, socio-economic status, lifestyle, and environmental conditions in various areas. Therefore, a pragmatic exposure audit for key household and environmental types will have to be undertaken in order to prioritize the range of interventions.

Both technical and environmental interventions in the area of faeces, waste water, soil contamination, and solid waste management are fairly well known and tested in many environments. The integration of multiple-exposure reduction interventions into a package that addresses not only environmental health but hygiene practice questions appears to be crucial. Health education and community awareness building are important cost-effective measures that can enable effective exposure reduction.

Differential exposure and vulnerability of women and children

Exposure levels

Limited data is available on the overall exposure of human population groups to various health risks. A broad estimate of overall exposure indicates that about 55% of human time is spent in indoor settings (Schwela 1996). There are no current published estimates of exposure disaggregated by domestic or occupational setting, gender, age cohort, or region in DCs. Given the wide variation in lifestyles and time-use patterns in the DCs, this is probably the most serious research gap in this area.

Exposure studies, especially those that focus on 'total exposure', are a critical missing link in the current research agenda. This needs to be urgently addressed.

Differential vulnerability

Independent literature from the anthropological, sociological, women's studies, and market research domains record high differentials in the time spent by women and children in domestic environments. The epidemiological relationship between the locus of activities, i.e., the domestic environment and the time over which a person is exposed to health risks has been repeatedly hypothesized but has not been clearly established for DC environments. This is especially true of factors such as crowding and psychological illness for which limited scientific evidence is available, even though 'common sense' provides a prima facie basis for this link.

Certain population groups, either because of their lifestyles, occupations, location or consumption patterns, are differentially vulnerable to specific health risks. This in combination with differential hazard exposure would put the individual or group at increased risk. The domestic environment is an important locus of human activity, especially for women and children. However, unlike occupational environments, the work done on differential vulnerability within the domestic environment in DCs is sparse. Within this, focused research on the poor, and women and children, who form the severely disadvantaged groups in many DCs, is even more limited. The following sections provide an indicative overview of the issues addressed in recent literature.

Vulnerability of the poor and socio-economically disadvantaged

Socio-economic status (taking into account factors such as housing conditions and land ownership) was found to have a definite influence on the birth and death rates in a large sample health survey of rural Kerala, India. Higher socio-economic status resulted in lower birth rate, independent of confounding variables such as age structure, location, and religion. The higher risk for mortality among poorer households was partly explained by material deprivation (Kutty et al. 1993).

A review of urban childhood mortality in Bangladesh found that residence of a single-room dwelling (odds ratio [OR] = 2.6) or a structure of inferior construction (OR = 2.6) were important environmental factors influencing child mortality (Stanton, Clemens 1988). Improvements in the housing and living environment of poorer households were found to be important factors in improving the health of children in Kampongs of Jakarta, Indonesia (Harpham et al. 1990). The quality of housing was found to have a marked influence on the prevalence of communicable diseases and on the standard of cleanliness of children in urban areas of Nigeria. It was found that a web of multi-interacting factors within the environment, and the socio-economic background of children had strong influence on the health of school-age children (Oduntan 1973).

Socio-economic factors mediate the interactions between households and their physical environment. In a sample study, they were found to determine access to environmental services, exposure to environmental hazards, hygiene behaviour, and the capacity to undertake protective measures. Through nutrition and health care, they also influence the outcome of exposure to environmental hazards. While focusing on malaria, respiratory, and diarrhoeal diseases as the principal childhood killers in Accra, Ghana, this chapter suggests the need for a holistic approach to environmental analysis (Songsore, McGranahan 1993).

Improvements in hygiene practices resulting from rehousing of two slum communities in Port Said in the 1980s were significant as indicated in the decline of bare-footed person, improvement in the state of cleanliness, soap consumption, and repair of clothing (Shawry 1965).

Population perceptions of illness, health, and the environment strongly influence popular understanding of linkages, and hence, intervention areas. A research study found that in the judgement of interviewed households no linkage was discernible between the

characteristics of their home and health problems. The study identifies how the possibility of good health was being closely associated with a socially-created living environment. It also reviews on how people living in different low-income settlements view health and environment (Jacobi 1990). A review of the influence pathways linking maternal education and child survival in developing countries recognized the need for additional research on the role of health beliefs and domestic practices, and intervening factors and mechanisms (Cleland, van Ginneken 1988).

Vulnerability of women

The linkages between women's health and housing and the domestic environment is a highly under-researched scientific area. This is especially true of DCs and even more so of rural areas in which a large proportion of vulnerable women and women-headed households live.

Low-income groups (and within such groups specifically women and children) are forced to bear most of the health burden of environmental hazards in urban areas. Equity considerations suggest that the groups most affected should have an influential role in setting priorities for environmental improvement if limited resources are to permit significant improvements (Satterthwaite 1993).
The availability of a toilet, drinking water contamination, the gender ratio of the households, and the quality of social support networks were found to statistically predict 35% to 91% of the morbidity variance between single woman headed and other households in rural Peru. Case studies also showed that the degree of illness among single woman headed families was affected by small differences in their social and physical living conditions (Carey 1993).

A review of literature indicates that women are disproportionately affected by lack of basic infrastructure. They are primarily procurers and users of water, and in most communities, they have the sole responsibility for waste management and sanitation training. Consequently, women are at a significantly higher risk of exposure to disease and generally have poorer health than men. Their children are at high risk as well as indicated by high maternal and infant mortality rates. Further, because women are increasingly the primary wage earners, both chronic illnesses and time taken for gathering water from inconvenient sources constrains their inability to be available for the families. Women's difficulties are further accentuated by social customs and cultural constraints that limit their access to community decision-making and planning.

Women's participation has been shown as a means of improving projects as they understand on how they conform to their needs and priorities. Women's engagement with water supply and sanitation issues are of vital importance (Jordan, Wagner 1993).

Limited published research was found on the specific role and impact of women-headed households, and on women in deprived communities and the built environment. However, in a well-researched paper, low female participation in vector control activities at the household level were found to be related to women's power and authority within the domestic domain. The negative impact of intrusion into the domestic space by male vector control personnel, reorganization of the domestic environment as part of control activities, and the promotion of ideas that diseases generate within the home have been identified. In addition, the fact that women need to invest significant amounts of time and money in order to carry out recommended measures is little appreciated. Very little is known about the impact of vector control programmes on women (Winch et al. 1994).

There appears to be a critical gap between the scientific, policy, and secular literature that needs to be filled. It is quite apparent that, given the current tools and methods available, this can only be closed by intensive interdisciplinary and cross-cultural research. The differential exposure by gender and age due to lifestyle, occupation, and role functions is an emerging area of research, and inter-disciplinary enquiry between the medical, design, and social sciences requires both funding and academic support.

Housing-related health risks by key disease groups

A detailed review of the housing-related health risks in DCs by disease groups is presented in the following section. The key disease groups include respiratory infections, diarrhoeal diseases, malaria, flavivirus infections, Chagas disease, rheumatic heart diseases, and radon exposure.

Respiratory infections

Acute respiratory infection is the most frequent illness globally, and is a leading cause of morbidity and mortality in children, and probably the leading cause of morbidity among young children in DCs.

Annually, an estimated four million deaths of children under five are ascribed to ARI (Stansfield, Shepard 1993).

The clinical syndromes causing ARI mortality include pneumonia, measles, pertussis (whooping cough), diphtheria, and pharyngitis. Upper respiratory infections (URI) affect the respiratory tract above the epiglottis (e.g., common cold) as opposed to the acute lower respiratory infections (ALRI) (e.g., pneumonia). Most ARI episodes are reported to be self-limiting and mild, requiring symptomatic treatment and general supportive measures. Severe ARI, particularly of the lower respiratory tract among young children, can be very serious.

Disease burden

A global review showed that ARI accounted for 6.3% of all mortality (Bulla, Hitze 1978). Mortality is highest in infants, pre-school children, and old people with considerable differences across groups and locations. An average urban child was found to have between five to eight ARI episodes per year (Frey, Wall 1977; James, 1972, Datta et al. 1969). Episodes in rural areas are reported to be lower at one to three per year (Dodge, Demeke 1970; Gordon et al. 1968).

Estimates of prevalence indicate that children typically spend 20%–40% of observed weeks with ARI, and up to 14% of observed weeks with more serious ALRI (e.g., pneumonia). The greater public health significance of ARI in DCs is the high relative frequency of a LRI with mortality rates 10 to 50 times higher than in developed countries. In many countries, ARI often surpasses diarrhoea in importance, as a cause of child mortality.

Risk factors

The key reported risk factors for ARI incidence include being less than two years or more than 65 years old, poor nutritional status, and lack of breast-feeding. The key environmental risk factors are indoor air pollution and crowding. Crowding is also indicated as a risk factor in increased case fatality.

Little is known about the relative importance of various pathogens that cause ARI, and the socio-economic and environmental factors that influence the transmission of and vulnerability to this group of infections. Since ARI mortality is prevalent primarily among children and the old, most research and statistics are focused on these age groups.

A number of studies in DCs (Verma, Menon 1981; Stansfield 1987; Tupasi et al. 1988; Borrero et al. 1990; Vathanophas et al. 1990) have demonstrated an increased frequency of pneumonia requiring hospitalization among persons in more crowded households. Crowding has also been suggested as a predictor for increased case fatality due to measles (Aaby 1988). A detailed review of literature on the key risk factors is given below.

Overcrowding

Crowding has been long proposed as one of the most significant risk factors of respiratory infections, starting with tuberculosis. Few rigorous studies have been able to establish the independent role of crowding in increased ARI transmission. An early review of health indices of three groups of Hong Kong children in the age group of five to seven years (with no differences in nutritional status) found that the population density per room quadrupled in the move from villages to urban squatter areas, accompanied by a higher prevalence of respiratory diseases (Worth 1963). Dense crowding of indoor sleeping quarters during cold and wet seasons was found to be one of the significant factors in respiratory virus transmission, in children, in a comparative study of village, peri-urban, and crowded urban environments in West Bengal, India (Bang et al. 1975).

More recently, a study of respiratory diseases and pulmonary tuberculosis in urban Medellin, Columbia found high prevalence among those sleeping in badly ventilated or overcrowded quarters (Zuluaga et al. 1992). Crowding as measured by the number of siblings per room was also found to be a risk factor for ALRI in young rural Kenyan children (Ballard, Neumann 1995).

Since a clear relationship cannot be discerned from this sparse research, a linkage between crowding or floor space norms per person and public health is currently based on established practice and incremental standards.

Poor ventilation

Poor ventilation and associated indoor air pollution has become a major area of research enquiry, since its identification as a major health risk (especially for women and children). However, few case-control studies examine the specific role of ventilation in ARI in DCs.

Poor ventilation of the living room, cigarette smoking, and other socio-economic factors were found to be the risk factors for ARI in a

surveillance study of four villages in rural China. The highest ARI incidence was reported in children under one year of age followed by those between two to six years of age (Wang et al. 1994).

A case-control study of under-five mortality in rural Ethiopia found that the absence of a window – a proxy measure for evaluating the type of housing – had an influence on ARI mortality (Shamebo et al. 1993). An increased prevalence of chronic bronchitis in females in rural Kashmir was attributed to exposure to domestic smoke pollution, poor housing, and overcrowding. The prevalence rate among females was found to be 12% compared to 8% across the entire population (Qureshi 1994).

Incense and mosquito repellent burning showed effects on reports of coughing among primary school children in rural Taiwan (Yang et al. 1997 a). This is an increasing phenomenon in urban areas in the developing world, and may need to be tracked.

More work has to be done on indoor air pollution studies to determine the precise role and mechanisms of ventilation on increased exposure and vulnerability to ARI in both women and children before any conclusive findings on the influence of housing on ARI can be clearly articulated.

Dampness

Dampness in homes is another inadequately understood risk factor which is related to ground conditions, drainage, floor type, and barriers to the penetration of damp. A few studies examine this topic in detail. Home dampness was found to be significantly associated with respiratory health symptoms of primary school children in rural Taiwan (Yang et al. 1997 b). The adjusted OR for asthma prevalence was found to be 4.9 for dampness in the sleeping area of school children in a case-control study in urban Nairobi, Kenya (Mohamed 1995).

Dust and domestic environmental factors

Dust and home environmental factors were found to be strongly associated with asthma and other respiratory disorders. A study of asthma in Barbados revealed that house dust is the most common allergen, and is responsible for the precipitation of naso-respiratory symptoms (Pearson 1973). Differential exposures related to the domestic environment were found to influence the prevalence of wheeze and asthma in urban as compared to rural subsistence areas of Ethiopia. Wheeze sensitivity was positively associated with housing

styles and bedding materials (Yemaneberhan et al. 1997). The prevalence of household dust mites in rural North-eastern China was found to have a close relationship with asthmatic disease (Du et al. 1993). A case-control study of school children in urban Nairobi, Kenya found that the adjusted OR was 3.6 for the presence of rugs in the child's bedroom and 2.5 for indoor air pollution (Mohamed 1995). In another study, relative humidity within the house was found to be the principal factor influencing the distribution and abundance of house dust mites which in turn caused allergic reactions and asthma (Yassin, Rifaat 1997).

Livestock rearing in the house

A significant relationship between livestock rearing in the house and respiratory illness and tuberculosis was found in a study of rural communities in India (Sen et al. 1992). Tuberculosis transmission is an old area of concern in DCs; but could still be a significant emergent factor with the expansion of livestock rearing as an income-enhancing activity especially since the bulk of houses continue to be single-roomed.

Inadequate housing conditions

A number of papers report the relationship between 'inadequate' housing conditions and ARI. Inter-comparability is difficult due to the lack of a clear definition of 'inadequateness'.

A study of the prevalence of common cold shows that the children in the squatter areas of Singapore have a higher incidence than those living in flats (Kleevens 1972). Inadequate housing was found to have an OR of 2.09 for the incidence of chronic bronchitis in an urban area of Brazil. High levels of indoor air pollution had an OR of 1.6 (Menezes et al. 1994). ARI was found to be significantly associated with sub-standard housing conditions in a case-control study of ARI in the first 18 months of life in urban Chile. (Lopez Bravo et al. 1997). There is a definite need to arrive at a clear definition of 'inadequate' housing in the context of the local environment and socio-economic conditions of their residents. An approach based on conventional housing standards may not be equal to this task.

Prevention and control

Screening and discriminating between mild and severe ARI by mothers and primary health workers is seen to be a major intervention

to reduce morbidity in DCs. The focus of most interventions and research is on immunization and drug-based case management. Chemotherapy is the preferred instrument of clinical management but specific vaccines are limited in effectiveness and availability, and are considered largely inappropriate in a DC context.

Apart from nutrition, social and environmental factors have been identified as the key intervention areas for long-term decline of ARI (Keresclidge, Leowski 1985). The feasibility of environmental risk reduction interventions in the literature is reported to be less than improving the nutritional status (Stansfield, Shepard 1993).

From the analysis of key risk factors, it was found that overcrowding combined with poor ventilation, dampness, and dust proliferation were found to be the important domestic environmental factors in ARI. The most important macro-intervention would be the provision of adequate floor area to each resident wherever affordable, decongesting highly dense urban and rural settlements, and wherever this is not possible, providing them with adequate light and ventilation. This is an important consideration for urban slums where a number of successful environment improvement programmes have been initiated by a ventilator upgradation intervention.

Damp and dust prevention can be achieved by structural means, by providing floors and moisture barriers of permanent materials and adequate quality openings. Since all these interventions imply significant investments, a comparative cost-benefit analysis would have to be undertaken as a pilot programme to establish the efficacy of these measures.

Diarrhoeal disease

Diarrhoeal disease is a complex of symptoms of which more than three stools in 24 hours of observation (after the age of three months) is a leading indicator (WHO 1988 a). Dysentery is characterized by the presence of blood in the stools, with or without excessive looseness or frequency. Diarrhoea is the first or second most important cause of childhood death and claims the lives of over two million children in the developing world (UNICEF 1997). Infectious agents, including various bacteria, parasites, and viruses cause most cases. Diarrhoea is also one of the major causes of malnutrition worldwide.

Vibrio cholera, *Shigellae*, *Escherichia coli*, and *Salmonella typhi* are among the most important bacterial agents. *Giardia lamblia*,

Entameoba histolytica, Stongyloides and *Trichuris* are the key parasites responsible for diarrhoea. Rotaviruses and other viruses are reported to be responsible for over 30% of childhood diarrhoea.

Disease burden

Age-specific incidence is associated with weaning and introduction of foods, peaking roughly at an age of two, and declining gradually after that. Adults are estimated to have less than one episode per year. A series of WHO surveys indicate that, on an average, children under the age of five suffer three to four episodes of diarrhoea per year in DCs (Martines et al. 1993). Estimated annual diarrhoeal mortality rates decline from 6.5 per 1000 in less than 5 age group to 3 per 1000 in the 5–14 age group, and 0.1 for higher age group.

Risk factors

The primary risk factors associated with diarrhoea are lack of breast-feeding, bottle feeding, contaminated food and water, malnutrition, faecal–oral transmission, and lack of access to rehydration materials. Unclean living conditions are found to be associated with an increased risk of diarrhoeal disease (Bertrand, Walmus 1983; Huttly et al. 1987; Taylor et al. 1986). A review of risk factors is detailed below.

Overcrowding

Diarrhoeal risk factors relating to the domestic environment for young children living in urban and peri-urban areas of South Africa was estimated at 2 for a density of more than two persons per room, at 2.5 for those not owning a refuse receptacle, and at 3.3 each for those not having an inside tap or a flush toilet. Diarrhoea incidence was reported among 8.5% of the children under five years of age (Von Schirnding et al. 1991).

Inadequate housing

The prevalence of entero-pathogenic bacteria among infants with diarrhoeal disease was more frequently isolated in households living in sub-standard dwellings. The differences in rates among the various sub-standard dwelling types (6%–10%) contrasted remarkably with zero-infection rates in better type of houses (Kourany, Vasquez 1969).

The dramatic reduction in the incidence and mortality of gastro-enteritis in black urban populations of Johannesburg and Cape Town directly attribute to improvements in housing, sanitation, and nutrition (Schoub, Berkowitz 1983).

Housing quality and appearance was found to be the third most important predictive variable for diarrhoeal disease in young children following detailed maternal attitudes and practice survey in urban Colombia (Bertrand, Walnus 1983).

The transmission of *S. stercoralis* was found to be mainly in the vicinity of community latrines within houses where an earth floor is associated with the risk of increased infection. OR for earthen floor houses was 2.6 compared to cement floor houses, and 2.87 for bamboo roof houses compared to concrete houses. Changes in the household environment, especially the construction of cement floors was found to reduce the transmission of infection (Hall et al. 1994).

The risk factor for *Cryptosporidium* diarrhoea in early childhood in a case-control study from Guinea–Bissau was found to be keeping of pigs (OR = 2.5) and dogs (OR = 2.1) inside their houses (Molbak K 1994).

Inadequate water supply and sanitation

Environmental sanitation is clearly one of the most important interventions related to diarrhoeal disease. This is a well-researched area even in DCs. Only key studies that have bearing on the domestic environment have been reported below.

Data from a field control study of four communities over five years showed that the provision of sanitary facilities for human waste disposal can reduce cholera incidence by as much as 68%, safe water supply can decrease it by 73%, and if both are provided reductions of 76% can be achieved (Azurin, Alvero 1974). Children (less than four years) living in houses prone to flooding, and those with poor sanitation and water supply were found to be at significantly greater risk of diarrhoeal disease in a survey of six Malaysian villages (Lye 1984). A dramatic reduction in the incidence of mortality, and gastro-enteritis of black urban population of Johannesburg and Capetown, South Africa was a direct result of improvements in nutrition, housing, and sanitation. The study concluded that immuno-prophylaxis should be secondary to an improvement in socio-economic and housing conditions (Schoub, Berkowitz 1983). The lack of housing and adequate W&S is linked to the outbreak of an epidemic of *Shigella* dysentery in urban South Africa (Rollins et al. 1995).

The important risk factors identified in a longitudinal comparative study of parasitism and diarrhoea of children in both rural and urban settlements in Honduras were faecal contamination,

lack of potable water, and inadequate housing in the midst of poverty (Kaminsky 1991).

In a multi-stage sample study, it was found that overcrowding, absence of toilets inside houses, and refuse receptacles were the risk factors for diarrhoea in young children living in urban and peri-urban areas of South Africa (Von Schirnding et al. 1991).

A community-based study undertaken to compare aetiological factors for infant diarrhoea found that pathogens occurred more frequently in those families with poor housing and sanitation and confirmed that environmental factors are compounded by other issues (Loening et al. 1989).

Investment in expensive latrines did not necessarily reduce intestinal parasitical disease. Personal and domestic cleanliness, reduction of neighbourhood environmental contamination, and improvement of neighbourhood services are important interventions that may help reduce intestinal parasitical diseases in urban Africa (Feachem et al. 1983 b).

Prevention and control

The key environmental interventions for diarrhoea control among young children include improving water supply and sanitation facilities (Esrey et al. 1985), controlling flies (Esrey et al. 1991), and zoonitic reservoirs (Martines et al. 1993). Interrupting transmission of diarrhoeal disease by these methods can induce a reduction of 27% in diarrhoeal incidence, and 30% in diarrhoeal mortality. There are, however, a large number of constraints in reducing diarrhoea incidence by improved water availability and quality, which include technical constraints (e.g., unprotected sources, leaking pipes), inadequate storage and use (post-treatment contamination), and hygiene practice.

The ideal long-term prevention strategies include longer breast-feeding, immunization, and improvements in environmental sanitation and water supply which are reported to be relatively expensive. Key case management interventions include rehydration, convalescent care, and drug therapy.

The key domestic environmental interventions related to diarrhoea is the provision of safe water supply along with effective sanitation and reduction in overcrowding, improvement in floor quality, and changes in hygiene practice. The cost implications of these interventions vary with the technology and delivery systems, at the same time sustainable reduction in diarrhoeal disease without some change in these factors seems improbable.

Malaria

Malaria is a collective term for various diseases that result from an infection of the parasite of the genus *Plasmodium*, which is usually transmitted through the bites of mosquitoes of the genus *Anopheles*.

Disease burden

Over 270 million people are estimated to be carrying malarial parasites without necessarily developing symptoms, and an estimated 110 million clinical cases are reported (Najera et al. 1993). About 27% of the world population is estimated to live in areas where malaria never existed; 32% in areas which are now malaria free; a further 32% live in areas where endemic malaria has returned after control measures were implemented; and 9% in areas where malaria control has not been attempted. These last two regions host 85% of the malaria cases. A global trend over the last two decades is a resurgence in malaria incidence along with resistance to anti-malarial drugs.

Malarial mortality is highest among the young. Mortality rates are estimated to range from 10 to 30 per 1000 for infants, and 7 to 11 per 1000 in children under five (Najera et al. 1993).

Risk factors

Malaria transmission is complex, and involves a dynamic interplay between the parasite, vector, and human population. The primary risk factors identified for malaria are high vector density and survival rates and favourable environmental conditions for vector propagation and human-vector contact. A detailed outline of the domestic environmental risk factors is given in the following sections.

Inadequate housing

Malaria in urban areas is clearly effected by human-vector contact which can be reduced by improved house construction (Najera et al. 1993). The relationship between the construction material and the quality of house construction and malaria has been fairly well-established in a number of cases, across Asia and Africa. Changes in rural living conditions that lead to malaria are also well-documented. An upsurge in the transmission of stable malaria was linked to the replacement of traditional village huts with modern social housing (Anthony et al. 1992).

Changes in roof form and design and screening of all openings are important anti-mosquito measures within the house. Improved environmental sanitation to reduce waste water and prevent mosquito

breeding in peri-domestic areas are two important physical measures to reduce malaria.

People living in thatch houses were found to have a relative risk (RR) of 6.72, while those without a false ceiling had RR = 11 as compared to those in tiled houses RR = 1 for malaria infections. This data corroborates earlier study that transmission is a local problem and varies according to micro-epidemiological factors (Subramanian et al. 1991). The risk of getting malaria was found to be greater for inhabitants of the poorest type of house construction with incomplete earth or thatch walls and thatch roofs compared to houses with complete brick and plaster walls and tiled roofs. Houses that were better constructed had significantly lower malarial incidence rate (11%) than those that were poorly constructed (21%). There were also a significantly higher number of indoor mosquitoes in poorer houses (Gamage-Mendis et al. 1991). OR for risk of malaria in peri-urban Gambia was estimated at 1.7 for houses with earth walls, 1.4 without false ceilings, and 1.7 for more than three persons per room (Koram et al. 1995). Sub-standard living conditions and overcrowding were found to be major risk factors for both malaria and non-malaria mortalities in a review of the control of infant and early childhood malaria. Improved housing conditions and ante-natal care are listed as potentially cost-effective strategies for malaria control (Kuate Defo 1995).

Screening openings in both rural and urban settings, with or without impregnation have been found to be effective. The biting behaviour of Anopheles mosquitoes was found to be significantly influenced by the use of sisal curtains impregnated with permethrin placed under the eaves of village houses in a study in rural Kenya (Githeko et al. 1996). An assessment of damaged nets and curtains to protect against mosquito-induced malaria in rural Tanzania revealed that sisal eaves curtains deter mosquitoes from entry but do not kill those that had entered (Curtis et al. 1992).

Ineffective vector control

Vector control is an effective intervention against malaria but is constrained by the need for high levels of compliance and community involvement. Households in dense urban areas were found to use some form of domestic mosquito control products for their personal protection, and many spent a significant portion of household income for protection from mosquitoes. Residents were, however, found to be unable to distinguish between breeding sites that produce malarial mosquitoes and other nuisance-causing mosquitoes (Stephens et al. 1995).

A WHO report on new approaches to vector control caused by the challenge of rapid urbanization found that densely-packed housing and inadequate urban services created favourable habitats for the proliferation of vectors and reservoirs of communicable diseases. It recommended that municipal authorities need to use flexible methods based on integrated sound environmental management practices, community education, and mobilization with minimal reliance on routine pesticidal spraying to effectively deal with mosquitoes (Knudsen, Slooff 1992). Planned housing, adequate water supply, proper drainage facilities, and sanitation are identified as the key interventions to achieve vector control of malaria (Yadava et al. 1991).

A community-based *Aedes aegypti* vector control programme in urban Mexico demonstrated that a community-based communication programme aimed at elimination or control of larva production site can be effective in changing behaviour and reducing production sites (Lloyd et al. 1992). A pupal mosquito survey of *Aedes aegypti* in Trinidad revealed that environmental sanitation efforts within and outside the household along with adequate water supply, eliminating the need for drum and bucket storage, has the potential to reduce the sources responsible for the vector by more than 80% (Focks, Chadee 1997).

A study of malaria transmission in the slum areas of Delhi, India, found that high densities and inadequate sanitation facilities along with poorly implemented anti-vector and anti-parasitic measures have led to these areas becoming major sources of infection in the city.

Prevention and control

The major control strategies for malaria include chemical control through residual spraying, treatment of fever cases with antimalarial supported by environmental measures including reduction of man–mosquito contact by modifying house material and design; screening of openings and use of bed nets and protective clothing; increased mosquito mortality using domestic spraying; destruction of mosquito larvae through peri-domestic sanitation improvements; intermittent drying of water containers; and source reduction through biological control, environmental sanitation, water management, and drainage.

Flavivirus infections

Flavivirus infections, especially yellow fever, dengue, dengue haemorrhagic fever, and Japanese encephalitis are emerging

as significant diseases in DCs, especially those with uncontrolled urbanization along with inadequate environmental health measures.

Yellow fever is endemic in Africa and South America, especially in urban areas, where epidemics are not uncommon. The key vectors are mosquitoes – *Aedes aegypti, A. simpsoni, and A. africanus* – apart from some sporadic transmission through monkeys.

Risk factors

The primary risk factor for this group of diseases is living in an area where the mosquito vectors are prevalent. There is no evidence of greater risk for any age group to yellow fever. The peak incidence of dengue haemorrhagic fever is in the three to six year age group with the highest mortality rates being confined to those under 15.

Housing

A retrospective sero-epidemiologic survey of two municipalities in Cuba found that dengue infection is favoured by the presence of vectors in and around housing (Guzman et al. 1989).

Housing conditions have been identified as a significant factor in dengue transmission in both urban and rural areas. A detailed study of clinically diagnosed and confirmed cases of dengue haemorrhagic fever in Kuala Lumpur, Malaysia found that the disease was most severe in children under 15 years and among the Chinese population due to their living in crowded and low-income housing where the vector *A. aegypti,* occurred in greatest numbers (Wallace et al. 1980). Low socio-economic status associated with wooden and slum housing was found to lead to an increased incidence of dengue infection probably by providing a high number of mosquito-breeding sites and favourable conditions for mosquito human contact. Unscreened houses were also identified to be a significant risk factor for dengue transmission (Waterman et al. 1985). Dengue has been identified as a vector-borne infective disease that is likely to bridge the gap between health transition in tropical countries. Upgradation to modern housing in Singapore and Taiwan has lead to an increase rather than a reduction in breeding places for *A. aegypti.* Greater affluence often implies less compliance with mosquito control programmes (Halstead et al. 1994).

Screening openings was also found to be an effective strategy to control dengue in a case-control study in Taiwan that estimated the adjusted OR for screened houses as compared with unscreened houses as 0.58. OR was as low as 0.18 for residents of houses which were fully screened with door screen openings upwards. Patients who lived near open sewers, drains, and markets were found to have a risk of

dengue infection 1.8 times higher than those living elsewhere. The reduction of outdoor vector sources and complete screening with outward opening screen doors were found to be the best protection against dengue fever (Ko et al. 1992).

Prevention and control

Both dengue and yellow fever transmission can be intercepted by eliminating the Aedes mosquito vectors either by chemical spraying or by eliminating breeding sites (Chan 1985). *Aedes aegypti* is a peri-domestic mosquito which breeds in waste water containers and solid waste sites. Residual insecticide spraying of building interiors to keep the Aedes index below five per cent was found to be effective in the prevention of yellow fever epidemics.

Vector control measures though more difficult, seem to be very effective. Community mobilization and health education are important inputs to this process. The screening of openings, especially in houses close to mosquito breeding sites, is an important physical intervention in the built environment.

Control of Japanese encephalitis is most effective by reducing human–pig contact as large-scale vector control has been shown to have limited effectiveness. Vaccine trials, especially among children have been found to have some success.

Trypanosomiasis (Chagas disease)

American trypanosomiasis or Chagas disease is one of the few infectious diseases that is directly linked to housing. It is caused by infection of the pathogen *Trypanosoma cruzi*, which is transmitted by blood-sucking insects of the *Triatomine* family through their faeces that infect humans via skin abrasions and mucous membranes.

Disease burden

The WHO estimates that over 30 million people are exposed to the risk of infection and 7 million are infected (WHO 1988 b, Lumsden, Marsden 1985). Infection is usually acquired in the first 10 years and stays for life, though only 15% of the infected population is estimated to develop clinical symptoms, including heart disease. The infection is currently restricted to South America.

Risk factors

The primary risk factors are living in poverty and inadequate living conditions, and in houses with earth, wooden, and wattle and daub

walls with thatch roofs on timber substructure. Cracks in these buildings are colonized by the vector.

Roughly-plastered wattle and daub houses have been identified in earlier studies as a conducive environment for breeding of the bug. The article claims that short-term control can be achieved by using insecticides but long-term solution lies in improved housing and living standards (Prata 1972).

An epidemiological survey for *Triatoma infestans* in a rural village in Argentina that was reconstructed after an earthquake found that 69% of the infected buildings were made of adobe and cane walls with cane and earth floors, and 23% with partially upgraded houses (Valve et al. 1991). Housing improvement, elimination of vectors by dwelling insecticide spray, and health education have been identified as the key factors to interrupt the domestic cycle of transmission of chagas disease. Following a major intervention using these tools, significant reduction in disease prevalence has been reported from 10% to 1% of sero-positive individuals (Lorca et al. 1996).

Intervention in housing improvement has been identified as a complementary activity within the integrated control of chagas disease in Brazil, especially after the completion of the global chagas disease programme attack phase, which led to a drastic reduction in the disease due to regular insecticide spraying in the endemic areas (Dias 1991). An evaluation of the efficiency of chagas disease control programme using insecticides in Brazil found a 95% reduction in areas in which interventions have been carried out for 10 years and 63% reduction for five years. The level of infestation ranged from 17% to 30% for houses in the study area before the intervention (Carneiro, Antunes 1994).

Prevention and control

The upgradation of earth, thatch, and timber-walled houses to concrete and brick walls with concrete or corrugated iron sheet roof is the primary long-term method of prevention. This, however, is very expensive, and often beyond the capacity of households and that of many DC governments.

The traditional methods of dealing with vector infestation include abandoning infected houses, setting fire to them or sealing cracks with earth. A Venezuelan programme of replacing thatch roofs with corrugated iron was partially effective. The efficacy of closing cracks with earth plaster in Brazil was limited by the plaster quality and the possibility of vector escape from the walls into thatch roofs.

The main method of control is by using residual insecticides. The Brazilian control programme is organized in three phases: (i) mapping

infected houses and using insecticide spray to drive vectors out of their hiding places; (ii) intense insecticide application to infected houses and those in their vicinity, especially to the roof, inner, and outer walls. A second spraying of infected houses follows after three months; and (iii) active vigilance.

Drug treatment of chagas disease is currently unsatisfactory.

Intestinal helminthic infections

Globally, intestinal helminthic infections are among the 10 most common infections (Davis 1985). Direct mortality and morbidity due to these infections are relatively low. Nevertheless, they have severe nutritional effects on children and lead to various complications and impacts on the immune system. The key nematode infections include *Ascaris lumbricoides* (roundworm), *Ancylostoma duodenale* and *Necator americanus* (hookworm), *Trichuris trichuria* (whipworm), *Enterobious vermicularis* (pinworm), and *Strongyloides stercoralis.*

Transmission usually occurs through ingestion of infective eggs (ascariasis, trichriasis, and enterobiasis), cutaneous larval penetration (hookworms and strongyliodiasis), and auto-infection (reported in some cases of strongyliodiasis).

Disease burden

Helminthic infections are an important disease group in DCs. These infections have been ranked in the order of prevalence, mortality, and morbidity of primary infectious diseases in the developing world (Walsh, Warren 1979) – schistosomiasis ranks fifth; hookworm infection, tenth; ascariasis, fifteenth; trichuraisis, twenty-first; and filariasis, twenty-second in rank.

Current estimates suggest that more than one-third of the world population is infected with one or more species of parasitic worms. An estimated 10% of helminthic infections are sufficient to affect the growth and development of children in spite of being sub-clinical. This suggests that more than 100 million people may suffer some form of morbidity from geo-helminthic infections (Warren et al. 1993).

Given equal exposure to helminthic infections, all ages, both men and women are reported to be susceptible. Children and people who walk barefeet or those exposed to contaminated environments are most at risk to this class of infections.

Differential incidence could be traced to the significant differential exposure of women and children within the domestic

environment, especially where a combination of earthen floors, open earthen courtyards, and streets provide a fertile ground for the larval stage of many of these infections to develop effectively in moist soils.

Risk factors

Crowding and soil pollution are reported to play a major part in infection transmission, especially within the peri-domestic environment. The key environmental risk factors identified by the literature include crowding, inadequate sanitation, and inadequate water supply combined with socio-economic risk factors, such as poor living conditions, poverty, and 'illiteracy'. It is clear however that a 'complex of intermingled variables affect the outcome of intestinal nematode infections and it may not be possible to unravel the threads of causation in other than a general manner' (Davis 1985). A detailed review of literature on the key risk factors is given below.

House type

Four articles report a significant relationship between house type and helminthic infection in DCs. Stool examination undertaken in an area of poor housing condition in urban Durban, South Africa found that 92% of the inhabitants were found to have one or more species of helminthic parasites compared to 82% of the residents of corporation houses (Elsdon-Dew 1953). Housing status was found to influence the rates of intestinal parasitosis in a stratified sample household study in Martinique. The prevalence was greatest in the age group of 5–15 years and prevalence in rural areas was double of that of urban areas (Villon et al. 1983).

The prevalence of single and multiple helminth infections was found to be significantly higher in children living in wood or bamboo houses than in those built in concrete blocks, in a cross-sectional study of Panamanian pre-school children. The intensity of helminthic infection was greater in children from poorer environmental and socio-economic conditions (Holland et al. 1988). Those in the age group of 7–10 years living in a house with an earthen floor and using community toilets were found to be independently associated with stercoralis infection in a longitudinal study of an urban slum in Dhaka, Bangladesh (Hall et al. 1994). The house type in the first three studies is indicative of the living conditions of the infected households. The Bangladesh study establishes a linkage between floor type and helminthic infection. The high proportion of earth-floored houses in both rural and urban areas of the developing world is an indication of the need for further enquiry.

Inadequate sanitation

Improvements in sanitation along with changes in the domestic environment have been demonstrated to reduce the incidence of helminthic infections. The rehousing of families from urban slums into flats with modern sanitation facilities had a pronounced reduction in geo-helminthic infections in children under 13 years in Singapore (Kleevens 1966). Low levels of hygiene, poor drainage, and the absence of municipal services were found to be the essential factors influencing high worm infection rates, and load and re-accumulation after treatment in an urban slum environment of Nigeria (Fashuyi 1988). Improved sanitation and hygienic practices alone are not effective in reducing the risk of worm infections (especially in children) as long as the domestic environment is contaminated (Ayanwale 1982).

Faecal contamination

Faecal contamination of the peri-domestic environment is a serious risk factor in the transmission of helminthic infections. The high prevalence rate of soil-transmitted nematode infection among children and women in some plantations of Sri Lanka was found to reflect widespread faecal contamination of the environment due to poor and congested housing conditions and insufficient sanitary facilities. A control programme based on regular deworming of children and health education was initiated as the physical environment was not likely to change in the short term. Nearly 90% of the children and 86% women had at least one type of geo-helminthic infection. The most significant were ascaris (77% of the children and 70% women), trichurias, (70% of children and 57% women), and hookworm (41% of women and 23% children) infections (Sorensen et al. 1996).

A multi-country study of excreta disposal facility and intestinal parasitism in urban Africa found that the provision of superior W&S facilities to a small cluster of households or catering to an area may not protect families from infection if the overall level of faecal contamination of the environment is high (Feachem et al. 1983 b). A study of soil contamination with *Ascaris lumbricoides* eggs in low-income households of two Brazilian cities found that the contamination levels were 0.8 (indoor), 0.6 (defecation sites), and 0.3 (backyard) eggs per gram of soil. Households with flush toilets were found to be the sources of faecal contamination due to the absence of adequate sewerage system. Households with small children were more often contaminated and the keeping of pigs correlated with an increasing yard contamination. The contamination levels showed

no significant correlation with the presence or quality of latrines or flush toilets (Schulz, Kroeger 1992).

An evaluation study of a sanitation programme in Maputo, Mozambique found that faecal pollution of the household environment is more due to promiscuous defecation than to poor construction or maintenance of latrines. Households with at least one infected person appeared to be more likely to have ascaris eggs in the yard, though egg counts around latrines were only slightly greater in other areas of the yard and less than those immediately in front of the buildings (Muller et al. 1989).

Overcrowding

High settlement densities and crowding within the household are reported to be the risk factors in helminthic infections. An observational study in rural Nigeria found that high population concentration was one of the factors responsible for high ascariasis, trichuriasis, and hookworm infections among school children (Fashuyi 1988). Residential densities were found to influence the frequency of exposure to infective stages of Ascariasis, which in turn played a major role in determining individuals harbouring heavy infection in a community-based study of Ascarias distribution (Haswell-Elkins et al. 1989). A study of stercoralis infection in Jamaica found that the prevalence was highest among persons who shared a bedroom with a reference case and decreased significantly with increasing spatial separation. This was found to be indicative of close contact transmission, which has not been shown earlier for a geo-helminth (Lindo et al. 1995).

Prevention and control

The three main strategies used for controlling helminthic infections are hygiene education, sanitary disposal of faeces, and chemotherapy at regular intervals.

The most important environmental intervention strategies to prevent helminthic infections are improved sanitation, clean drinking water, and various vector control measures. A review (eight major studies) of community-wide sanitation improvement found evidence of a reduction (in seven) of enteric helminthic transmission (Feachem et al. 1983 a). Reduction in environmental contamination, actual use of latrines, and improvements in the domestic environment are critical factors necessary to reduce helminthic infections (Feachem et al. 1983 b). Urban slums are at increased risk as compared to rural settlements (Bundy et al. 1989, Kan et al. 1989). Little emphasis has been given in

the literature to non-sanitation related improvements in the domestic environment, which include upgradation of floor materials and street and courtyard paving.

The primary method of case management is chemotherapy, with an increasing focus on multi-species treatment. Community-based programmes for anti-helminthic drug administration have been suggested but have not proved successful on a large scale.

Streptococcal infection (rheumatic heart disease)

Group A Streptococcus (*Streptococcus pyogenes*) causes ARI including scarlet fever, rheumatic fever, acute rheumatic heart disease (RHD), glomeronephritis, and skin infections. Children are most prone to Streptococcus infection, which in the case of RHD can cause chronic valvular heart disorders and eventually premature death.

Risk factors

High density and magnitude of crowding are important environmental factors in the spread of infection. Inadequate housing conditions, unhygienic living conditions, and hot and humid weather have been identified as subsidiary risk factors.

A cross-sectional study of high risk in school children found that the prevalence of RHD was higher in households with overcrowded and poor housing facilities (Thakur et al. 1996). A survey of the epidemiology of RHD found that the crowding or the number of people sharing children's bedroom was a possible risk factor. It confirmed that overcrowding is an important factor contributing to the incidence of RHD (McLaren et al. 1975).

Prevention and control

Early diagnosis along with appropriate antibiotic treatment is the primary method of control of these infections. Housing conditions may be used as a variable in screening programmes to identify high risk cases.

Household injury

Disease burden

Unintentional injuries are estimated to cause close to 40 million lost DALYs among women and children under the age of 15 (World Bank 1993). Of this, close to 90% of the burden was in DCs. The highest

proportion of non-motor vehicle burden was because of falls (19%), drowning (11%), and fires (8%).

Risk factors

Burns are reported to be more prevalent among women and children with a great majority occurring in the domestic environments. In Lagos, more than half the burn injuries occurred among children with mortality ranges from 7% to 35%. Burns are also common among women who work on open or low-quality pressurized stoves. Domestic poisoning is also a significant cause of death and a majority of cases are reported to occur among children (Stansfield, Shepard 1993). Falls in the domestic environment are also a major cause of both mortality and non-fatal injury.

The incidence of home accidents (43%) was found to be the commonest form of accidental injury while women had a higher accident rate than men even though the evidence of crippling was higher in males in a study of rural Punjab, India (Gordon et al. 1962). A retrospective study found that cooking at floor-level, bedside fires, general architectural features, and epilepsy in mothers were the major factors that involved burn injuries of young children. Burn prevention was found to demand improvement in the design of houses and cooking methods among other factors. (Kalayi, Muhammad 1996).

Radon

Radon-induced health risks have been recognized in DCs over the last few decades. Expanding urbanization and industrial pollution have contributed to the use of radon-contaminated materials for house construction. Underlying soil and building materials and cracks in floors and walls were found to be major sources and pathways of entry of radon into households in Beijing, China. The relatively high radium content in building materials was found to explain the high indoor radon concentration in Hong Kong. This was found to induce lung cancer death, varied by the age of the building and the type of ventilation (Yu 1992).

Crowding

Crowding is one of the major underlying risk factor identified in housing-related health problems. A short review of the role of crowding is presented below.

ARI

A retrospective study on measles in urban Jakarta, Indonesia found that most children came from low socio-economic group of families living in unfavourable environmental conditions in crowded housing (Samsi et al. 1992). Crowding as measured by the number of siblings per room was found to be a risk factor for ALRI in young rural Kenyan children (Ballard et al. 1995). Overcrowding, absence of toilets, and absence of a refuse receptacle were found to be the risk factors for acute respiratory symptoms and diarrhoea in young coloured children living in urban and peri-urban areas of South African in a multi-stage sample study (Von Schirnding et al. 1991). Inadequate ventilation, domestic smoke pollution, and overcrowding were found to be significant factors in the prevalence of chronic bronchitis and asthma in rural Kashmir, India (Qureshi 1994). Traditional houses (OR = 1.7) with no windows (OR = 1.6) was found to be an environmental risk factor of under-five mortality in a case reference study in rural Ethiopia. Infants were found to have a higher OR than older children (Shamebo et al. 1993).

Diarrhoeal disease

Grossly crowded and insanitary dwelling conditions and low standard of living were responsible for the transmission of infection along with recurrent viral disease in a study of high tuberculosis prevalence in isolated Eskimo communities (Carey 1965). High population densities in Manila, the Philippines was found to be a significant factor related to cholera prevalence. Priority to improvements in environmental conditions is cited as an important intervention to reduce the impact of cholera.

Psycho-social stress

A significant DC article drawing on a representative sample study of households in urban Bangkok, Thailand, found that the objective indicators of housing quality and household crowding are little related to health. However, subjective aspects of housing and crowding, especially housing satisfaction, lack of privacy, and psychological distress were found to have detrimental effects on health. These three factors were found to have independent effects on the health outcome of both men and women (Fuller et al. 1993).

High densities were found to effect emotional strain among poorer members of the community. Density was not found to effect the deeper and more basic levels of emotional strain and hostility. The

doubling up of households or living on the upper floors of multistorey buildings were found to have an effect on emotional health based on a survey of households in Hong Kong (Mitchell 1971).

Crowded housing was found to be a significant lifestyle risk factor determining the prevalence of coronary heart disease among rural and urban Indian men. OR for crowded housing was 1.48 compared to sedentary lifestyle (1.47) and smoking (1.20) (Gupta 1996).

A guiding framework for analysis and research

The linkage between housing and human health has been analysed using three major frameworks over the last decade. The oldest is a modification of the traditional environmental health model (Cairncross, Feachem 1993; Mara, Alabaster 1995; WHO 1997). The WHO Healthy Housing Model (1989; 1993) and the modified PSIR framework (UNEP/UNDP/WHO 1997) are more recent entrants. A broad description and comparative analysis of the merits and demerits is presented below.

Modified environmental health framework

The oldest framework is based on a classical environmental health model modified in the early 1990s (Cairncross, Feachem 1993; Mara, Alabaster 1995) limited and classified by risk factor. This modified model identifies the linkage between housing and health across eight exposure dimensions: (i) disease vector concentration based on house siting; (ii) excreta-related infections (e.g., faecal–oral infections and helminthiasis); (iii) refuse-related infections (e.g., plague, endemic typhus, and faecal–oral infections); (iv) water-borne, waterwash, and water-based infections (e.g., diarrhoea, cholera, and infectious skin diseases); (v) water-related insect vector infections (e.g., malaria and filariasis); (vi) airborne infections (e.g., ARI); (vii) peri-domestic and adventitious insect and animal vectors (e.g., chagas disease); and (viii) floor resident parasites (Box 1).

This framework has been further modified by WHO (1997) based on Mara and Alabaster (1995). This simple framework makes a link between the principal risk factors and the three classes of disease: communicable, non-communicable, and psycho-social disorders. A brief outline is presented in Table 4. The linkage between risk factors and intervention measures is clear and relatively easy to communicate.

The linkage with housing processes and intervention in DCs is possible by extending this framework.

Box 1
The environmental health model

The major linkages between 'housing processes' and health as defined within an environmental health framework (Cairncross, Feachem 1993).

- Differential exposure to disease vector concentrations, based on house siting
- Exposure to excreta-related infections (e.g., faecal–oral infections and helminthiasis)
- Exposure to refuse-related infections (e.g., plague, endemic typhus, and faecal–oral infections)
- Exposure to water-borne, water-washed, and water-based infections (e.g., diarrhoeas, cholera, and infectious skin diseases)
- Exposure to water-related insect vectors (e.g., malaria and filariasis)
- Exposure to airborne infections (e.g., ARI)
- Exposure to peri-domestic and adventitious insect and animal vectors (e.g., chagas disease, zoonoses)
- Exposure to floor resident parasites

Healthy housing framework

The Healthy Housing framework was developed by WHO (1988, 1989) to facilitate the integration of various interventions in the housing and infrastructure sector with the overall objective of improving human and community health. The principles of healthy housing are presented in Table 5 and are clustered around five broad intervention sets: protection against communicable diseases; injuries, poisoning, and chronic diseases; reduction of psychological and social stress; access to a supportive living environment; and protection of populations at special risk. This framework captures most of the key housing processes, but it is difficult to establish linkage to risk factors and diseases.

Pressure–State–Impact–Response framework

The most recent framework is the PSIR which has its origin in 'sustainable development' and environmental sciences domain where it has been effectively used in the Global Environmental Outlook (UNEP 1997) and Sustainable Development Indicators Initiative

Table 4

Modified environmental health framework: indicators of unhealthy housing conditions

Principal risk factor	Communicable diseases	Non-communicable diseases	Psycho-social disorders
Poor fuel/defective ventilation	ARIs	Perinatal effects heart disease, chronic lung disease, lung cancer, fire/burns	
Defective refuse storage and collection	Insect-vector diseases, rodent-vector diseases	Injuries, burns	
Defective food storage and preparation	Excreta-related diseases, zoonoses, diseases due to microbial toxins	Cancer	
Poor location (near traffic, industry, etc.)	Airborne excreta-related diseases, enhanced infectious respiratory disease risk	Chronic lung diseases, heart disease, cancer, neurological/reproductive diseases, injuries	Psychiatric organic disorders due to industrial chemicals, neuroses,
Defects in buildings	Insect-vector diseases, rodent-vector diseases, geohelminthiases, diseases due to animal faeces, diseases due to animal bites, overcrowding-related diseases	Duct and dampness induced diseases, injuries, burns	Neuroses, violence, delinquency and vandalism, drug/alcohol abuses
Defective water supplies		Heart disease, cancer	
Defective sanitation	Faecal–oral diseases, geohelminthiases, taeniases, water-based helminthiases, insect-vector diseases, rodent-vector diseases	Stomach cancer	

Table 5
Principles of healthy housing

Protection against communicable diseases through:	Protection against injuries, poisoning, and chronic diseases
Safe water supply	Structural features and furnishings
Sanitary excreta disposal	Indoor air pollution
Disposal of solid wastes	Chemical safety
Drainage of surface water	Use of home as a work place
Personal and domestic hygiene	
Safe food preparation	
Structural safeguards	
Reduction of psychological and social stress through:	**Access to supportive living environment through provision of:**
Adequate living space, privacy, and comfort	Security and emergency services
Personal and family security	Health and social services
Access to recreation and community amenities	Access to cultural and other amenities
Protection against noise	
Protection of populations at special risk:	
Women and children	
Displaced and mobile populations	
The aged, the ill, and the disabled	

Source. WHO 1997.

(UNCSD 1996). This has been adapted to examine the environment–health interface in a recent WHO publication (WHO 1997). This adaptation is less than successful in presenting a unifying framework that can link the built environment through risk factors and transmission pathways of disease to human health. Examination of questions of differential exposure and risk, especially given complex non-linear and qualitative relationships between factors, is difficult to articulate and operate upon.

Need for an 'Alternative' framework and new research agenda for DCs

The 'gap' between the realities of health practice and policy and medical and scientific literature on the housing–health link in DCs

and the differential burden on women and children points to an inadequacy of the present framework of research and analysis. An 'alternative' framework that integrates differential exposure levels along with risk factors, transmission pathways, and diseases and intervention would probably more effectively respond to this challenge.

This would enable a linkage between housing and health through specific risk factors, and establish specific sectoral interventions to address these linkages. This would be a flexible multi-level framework that could enable structured analysis and prioratization of interventions at the level of the household, community, settlement, and sectoral/policy-level, as appropriate. The broad steps in operationalizing such a method are as follows.

1. Establish links between housing-related health risks and specific diseases or cluster of diseases. There needs to be a specific emphasis on communicable diseases and domestic injuries by house types and environmental service level. This could well be linked to secondary databases such as economic and social census in DCs.
2. Establish specific exposure and vulnerability of women and/or children to identified housing-related health risks. Considerable path-breaking research would need to be undertaken on exposure time, activities, and location of households, constraints in lifestyle modification by gender and age cohort. The specific vulnerability due to gender, age, socio-economic class, and nutrition will have to be established.
3. Identification of interventions in housing processes to mitigate these health risks would have to be undertaken by house type segments, infrastructure provision to take into account flexible space, material, and construction standards that are necessary in a DC environment.
4. Establish socio-economic lifestyle and environmental causes of differential vulnerability and exposure. Cross-cultural and interdisciplinary research in this area will have to be linked to local action plans for effective intervention.
5. Link extra-sectoral interventions to mitigate housing-related health risks to mainstream health and housing intervention.
6. Identify key institutions to spearhead and implement these interventions, and lay policy guidelines within which they may function.

Intervention strategies

The question of effective strategies to enable improvement in the health of women and children in DCs via housing is still open to enquiry due to severe information gaps and inability to cross-compare. The three macro options currently available are exposure modification, vulnerability reduction, and case management. The current medical focus is on case management or on vulnerability reduction using methods related to immunization. Vector control has focused its efforts, with partial success, on exposure modification. Exposure modification through fundamental changes in the built environment have hardly been investigated except in material upgradation programmes, screening, and residual insecticide application interventions in a few locations. This is clearly an area that needs to be further investigated. The key policy question that has to be addressed is the affordability and the consumers' willingness to participate in this process and the effectiveness of service delivery by public and private agencies.

Process interventions

The five key process interventions that have been identified are: (i) changes in lifestyles and space utilization practices; (ii) changes in hygiene practice; (iii) upgradation of environmental infrastructure and service levels; (iv) changes in housing and settlement policy to reflect environmental health concerns; and (v) participatory planning and management.

Environmental interventions

A clear definition of the bounds of the built environment and 'housing' would be necessary between all the major stakeholders before an effective intervention can be launched. The question of absolute or relative standards would also have to be addressed, especially in the DC context where many households may not be able to afford the options that are technically the most effective.

A segmentation of the environmental instruments to address different housing processes and socio-economic segments would be necessary to track and monitor the most effective interventions. The use of flexible 'incremental' standards may become necessary because of the constraints on participation and affordability of DC citizens.

Technical interventions

The key technical interventions that have been identified include vector control; provision of effective environmental services and environmental health barriers; modification of buildings, structures, and materials to mitigate health risks; alteration in building form and design to reduce health risks; and finally changing the microclimate in buildings for betterment.

Interventions in the built environment

The four key interventions in the built environment that emerge from this risk analysis are proper siting, upgradation of building materials, restricting vector exposure, and restricting spaces for propagation.

Proper siting

Adequate siting of houses and settlements is a critical factor in reducing exposure to risk factors. This is critical in relation to diseases such as chagas, malaria, and dengue. Poorer households have been shown to have differential vulnerability with respect to these diseases, largely because of being pushed into highly vulnerable sites in low-lying areas, next to canals or sewers or to fringe areas adjoining forests with high vector concentration. Zoning and land-use regulation will enable adequate siting, and in some cases, subsidized house plots which enable all households to participate equally in the land market – are the major areas for policy intervention.

Upgradation of building materials

The transformation of houses by upgrading building materials significantly reduces the risk to particular diseases, e.g., chagas disease. The primary building systems that need to be targeted under this intervention are roof cladding and substructure and floors and wall rendering. These interventions are often expensive and may need to be subsidized in DCs after due risk-benefit analysis.

Restricting vector exposure

Restricting vector exposure, especially of women and children is an important strategic intervention. This can be undertaken either through alteration of the house form (inserting false ceilings and increasing eave overhangs); modification of the space use in the house or by inserting physical barriers such as screens in openings and bed-nets. Modification in the use of space within the house and reducing the density of occupation are additional interventions that have been reported to be effective. Since many of these interventions require

little investment, but significant changes in lifestyles and behaviour; a large input of health education and community development may be necessary.

Restricting spaces for propagation

Most vectors have preferred spaces for hiding and propagation during both their day and life cycle. Cracks in walls, roof substructure and frames, ceiling, and floors provide effective environment for a wide range of vectors to hide and propagate. The main interventions that have been proved to be effective include an upgradation of the wall or roof material, and the use of residual insecticides. These insecticides could have significant environmental and health impacts, and are recommended as a last resort. Integrated vector control is a more effective long-term option.

Gender-sensitive interventions

Reducing the differential burden of disease and health risk in women and girl children will not be possible without a significant change in both the culture of research and programmed intervention. Emphasis on exposure modification strategies that are possibly within the span of control of women, rather than technology-intensive options may be necessary. Consultation and empowerment with education and training will enable women to take better control of the domestic environment that they already manage. Decision-making on the design and construction of the built environment also needs to be more sensitive and equitable to women's need and participation.

Child-centred interventions

In spite of an increasing sensitivity towards gender issues, most literature has little concern for the special requirements of children. This is especially important because of the high disease burden that domestic environment-related hazards impose on children. This includes the linkage between ARI and the building microclimate (due to dampness, inadequate ventilation, and indoor air pollution); vector exposure especially the link between floor quality and cleanliness and geo-helminthic load; contamination of food storage in domestic environment, and household injuries apart from questions of sanitation and hygiene behaviour. A series of child-centred interventions will have to be developed in keeping with the needs of specific locals.

Conclusion and recommendations

This chapter reviews the key policy and research trends that have helped define the relationship between housing and health in the DCs. It has identified the significant gap between problem articulation in the policy domain, which claims significant differential vulnerability of women and children; and medical and scientific literature which is rather sparse in this sector. A major gap has been identified in exposure studies, where little data is available on the actual exposure levels of women and children to domestic health risks in DCs. Further, only some health risks within the major disease categories are fairly well-defined. There is, therefore, a significant gap in the medical and scientific literature that needs to be filled with focused research.

The key disease groups that were identified to contribute to the housing–health linkage include respiratory infections, diarrhoeal diseases, malaria, flavivirus infections, chagas disease, intestinal helminthic infections, and household injury. Data availability and quality across these areas were found to be highly variable.

A review of the current analytical framework in this area concluded that there was need for an alternative formulation and a new research agenda focusing on DC problems and priorities. A series of process, environmental, and technical interventions were identified apart from the need for gender sensitivity and child-centredness in both research and pilot implementation programmes.

Stakeholder responsibilities

Within the international community, the challenge of this cross-cutting problem area will be inter-agency coordination, research definition, and programme design. There is clearly a role for additional action research to close significant gaps in identified areas such as exposure studies, risk mitigation, and exposure modification in the domestic environment, and gender- and child-centred programme approaches.

There are clear roles for various UN agencies, including UNCHS (housing and risk mitigation in the domestic environment), UNICEF (women- and child-centred programme development and exposure studies); UNIFEM (exposure studies), WHO (differential risk analysis and intervention prioritization); UNDP (pilot programme design and implementation) apart from UNEP (integration and research design). A number of bilateral agencies and departments within national governments may also be important partners in the process of grounding enquiry and implementation.

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Biofuels

Dependence on biofuels

Traditional fuels play a vital role in the developing world. More than two billion people rely on them to meet the majority of their energy needs. These fuels are obtained from the same natural environment on which people depend for food crops and grazing land for their animals.

The term 'traditional fuels' here refers to biomass fuels used mainly for domestic energy. These include wood, charcoal, agricultural residues, and animal waste. 'Fuelwood' refers to wood, which is used directly for fuel; the term 'wood fuels', includes fuelwood and charcoal. Traditional fuels are the dominant source of energy in the developing world. It is estimated that they account for about 20%–35% of the total energy consumption in the developing countries (DCs) (Table 1). In many countries – Burkina Faso, Ethiopia, Malawi, Tanzania, and Uganda, to mention but a few – the proportion can be as high as 90% (Leach 1987).

Table 1
Traditional energy consumption, 1973–93

Region	Traditional energy as % of total consumption		Percentage change since 1973
	1993	1973	
World	6	6	47
Africa	35	43	76
Europe	1	1	−14
North and Central America	2	1	106
South America	21	30	26
Asia	9	15	47
Oceania	4	6	16
China	6	11	54
India	23	41	58

Source. WRI 1996.

Use of traditional fuels can be divided into three broad consumption sectors: rural domestic, rural industry, and urban. Of these, the rural domestic sector is by far the largest, probably accounting for 70% to 90% of the total traditional fuel use in most countries.

Fuel use in the rural domestic sector

The most characteristic aspect of fuel use in the rural domestic sector is its informal and largely non-commercial character. In most cases, individual families gather their own fuel supplies from farming areas, common lands or other local sources to which they have access. The collection is usually done by women and children.

Given this diffused family-based nature of fuel collection in rural areas, it is not surprising that there are many uncertainties about the actual quantities involved. It is, however, evident that there are major variations in consumption, not only between countries and climatic zones but also at a detailed village level (Table 2). In some cases, even neighbouring families in apparently similar circumstances show widely different patterns of fuel consumption.

Table 2
Survey of biofuel use in developing countries (kg/capita-day)

Location	Type of fuel	Amount	Total	Comments
Peru				Average use per household.
Huancarama	Firewood	22.90	22.90	Does not include bagasse, dung,
Purcas	Firewood	9.20	9.20	corn cobs, kerosene, etc. which
Matapuquio	Firewood	8.70	8.70	are also used for cooking.
Gambia				
Rural	Firewood	1.40	2.60	
	Charcoal	1.20		
Urban	Firewood	1.60	2.80	
	Charcoal	1.20		
Ranga, Upper Volta	Firewood	0.73	0.73	Extent of millet stalk use in Ranga specified.
Boulenga, Upper Volta	Firewood	0.34	0.81	
	Millet stalks	0.47		
Kwemzitu, Tanzania	Firewood and charcoal	7.10	7.10	All uses of firewood included. Space heating makes up large fraction. Charcoal used for heating at night. Figures indicate per capita use in a family of three. In family of five, the per capita use is 4.5 kg/day.
Pakistan				
Urban	Firewood, Dung	0.49		
(lowest income group)	Crop residues			
	Kerosene	neg.		
		neg.		
	Firewood	0.51		
Urban (next to lowest income group)				
Nabagram Unions, Bangladesh	Firewood	0.53	0.97	'Other' category includes cow
	Rice straw	0.15		dung, jute, stick, rice hulls,
	Other	0.29		bagasse, twigs, leaves, and agricultural residues. Amount of kerosene used is negligible.

Contd...

Location	Type of fuel	Amount	Total	Comments
Uttar Pradesh, India				
Patharhat	Fire wood	0.80	1.72	
	Dung	0.61		
	Other	0.31		
Hariharpur	Firewood	0.53	1.66	
	Dung	1.13		
	Other	neg.		
Hazipur	Spring plants	0.33	1.38	
	Dung	0.78		
	Other	0.27		
Pindari	Dung	1.33	2.18	
	Agri. Wastes	0.69		
	Other	0.16		
Naraich	Dung	1.67	3.16	
	Agri. Wastes	0.86		
	Other	0.63		
Fateh Singh ka Purwa, India	Firewood	0–0.33	1.2–1.9	Range derived by classifying fuel use by size of household's landholding.
	Crop residues	0.46–0.7		
	Dung	0.55–0.97		No firewood used by small landowners (<3 acres); most used by landowners (>5 acres). Medium landowners (3–5 acres) use least crop residues and dung. Small landowners use most crop residues.
Gujarat, India				
Boria	Firewood	1.17	1.17	
Denapura	Firewood	0.89	0.89	
Meghva	Firewood	0.99	0.99	
Rampura	Firewood	1.08	1.08	
South India				
Arjunahalli	Firewood	1.56	1.62	Negligible amount of kerosene used.
	Crop residues	0.06		
Hanchipura	Firewood	1.40	1.60	
	Crop residues	0.20		Negligible amount of kerosene used.
Keelara	Firewood	1.52	1.68	
	Crop residues	0.16		

Contd...

Location	Type of fuel	Amount	Total	Comments
Sugganahalli	Firewood	1.35	1.35	Negligible amount of kerosene used
Pura	Firewood	1.38	1.38	
Ungra	Firewood	1.28	1.35	
	Crop residues	0.07		
Thailand				
Rural	Firewood	2.50	2.50	
Urban	Firewood	2.00	2.00	
Fiji				Estimated that firewood is the
Natia, Yasawa	Firewood	1.13	1.13	primary cooking fuel in 67% of
Yaroi, Lau	Firewood	1.11	1.11	urban households and 97% of
Nacamaki, Lomaiviti	Firewood	1.01	1.01	rural households. Kerosene, gas,
Nagelewai, Naitasiri	Firewood	0.78	0.78	and electricity are often used as
Isolated farmers	Firewood	0.92	0.92	supplements. Estimates for rural
Estimate for rural Fiji	Firewood	0.97	0.97	Fiji as a whole includes home cooking and food preservation.

Source. Smith 1987.

Agricultural residues such as straw and stalks, dung, twigs, and other locally available biomass materials are also used widely as domestic fuels throughout the developing world. Even where fuelwood is the principal fuel, families often supplement it with maize cobs, millet stalks, and other material, which is readily available. The use of these fuels is not, in itself, evidence that wood fuel is scarce, but in areas where it is traditionally difficult to obtain, agricultural residues and other biomass fuels may be the principal or, indeed, the only source of domestic fuel. This is particularly true in Asia – for example, in parts of Bangladesh, India, and China. Exclusive dependence on these fuels is relatively uncommon in Africa though they do play an important role in Egypt, Ethiopia, some Sahelian countries, and Lesotho and other Southern Africa countries (Barnard and Kristoferson 1985).

Biomass fuel use in the urban sector

The data available on the use of traditional fuels in the urban sector is also unsatisfactory in most areas. There is virtually no reliable data on the actual wood fuel quantities consumed at an individual household level, nor on how these quantities are affected by price and availability

of other fuels such as gas or kerosene. There is no data on the aggregate total fuel consumption of most urban areas either.

Although accurate data is lacking, there is nevertheless clear evidence that wood fuels, either fuelwood or charcoal, are used in large quantities in many DCs cities. Large trucks carrying massive loads of wood fuel are a feature of the major access roads to cities such as Dar stet Salaam, Bamako, Dakar, and Nairobi. In many smaller urban centres in Asia and Africa, between 50% and 90% of domestic energy supplies come from traditional sources (WRI 1996).

In contrast with the rural areas, virtually all urban transactions of wood fuel take place on a commercial basis. Within the cities, there is usually a well-developed wood fuel distribution system. Wholesalers obtain their supplies from a small number of central markets and distribute them to a network of retailers who sell through the local markets or door-to-door deliveries.

Increasing scarcity of wood fuels

Wood fuels are becoming more difficult to obtain in many areas of the developing world. Evidence from Botswana, Uganda, and Tanzania demonstrates that women and children now have to spend more time collecting wood fuel than that was readily available earlier.

In some areas, this has led to a change in family arrangements for fuel collection. Thus, in the Shinyanga region in Tanzania, the responsibility is being increasingly shared between men and women: women collect agricultural residues and shrubs from farm lands; the men, periodically assisted by their wives or children, collect fuelwood from government forest reserves some 20 to 30 km from their villages. A round trip takes between two and three days. Table 3 shows the estimated number of rural women affected by fuelwood scarcity, and Table 4 shows the labour involved in fetching wood.

Fuel scarcity and the use of time

Very few large-scale surveys have been done to study women's activity patterns in relation to fuel cycle. The quality and depth of time-allocation studies simply cannot be matched by short-term observation or one-time surveys. Efforts are being made to develop methods that use observation techniques to develop the survey instrument and then test results. Islam et al. (1984) questioned the applicability of sampling techniques developed in the west to survey work in Asia.

Table 3
Estimated number of rural women affected by fuelwood scarcity, 1990

Country	Forest as per cent of land area	Per cent of rural population	Per cent of household energy from fuel-wood	Rural women aged 10–59 ('000s)	Estimated rural women affected by fuelwood scarcity ('000s)
Northern Africa					
Algeria	1	48	29	3861	1120
Morocco	8	52	67	4219	2827
Tunisia	3	46	37	1146	424
Sub-Saharan Africa					
Angola	19	72	85	2164	1839
Benin	45	62	84	864	726
Bostwana	25	72	57	297	169
Burkina Faso	16	91	85	2413	2051
Burundi	9	94	77	1655	1274
Cameroon	43	59	74	2135	1580
Chad	9	70	82	1212	994
Cote d'Ivoire	34	60	70	2071	1450
Ethiopia	13	87	86	13087	11255
Ghana	42	67	86	2986	2568
Guinea	27	74	87	1306	1136
Kenya	2	76	79	5497	4343
Madagascar	27	76	84	2815	2365
Malawi	37	88	89	2609	2322
Mali	10	81	81	2178	1764
Mauritius	8	60	60	228	137
Mauritania	1	53	80	356	285
Mozambique	22	73	83	3354	2784
Niger	2	81	71	1879	1334
Nigeria	17	65	74	21628	16005
Rwanda	7	92	84	2013	1691
Senegal	39	62	82	1368	1122
Somalia	1	64	82	1439	1180
Sudan	18	78	82	6140	5035
Togo	25	74	83	774	642
Uganda	32	90	86	4719	4058
United Republic of Tanzania	38	67	89	6423	5716
Zaire	50	61	94	8296	7798
Zambia	44	50	86	1512	1300

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Country	Forest as per cent of land area	Per cent of rural population	Per cent of household energy from fuel-wood	Rural women aged 10–59 ('000s)	Estimated rural women affected by fuelwood scarcity ('000s)
Latin America and Caribbean					
Argentina	16	14	43	1319	567
Bolivia	45	49	81	1088	881
Brazil	66	25	32	11345	3630
Colombia	52	30	60	2949	1769
Cuba	15	25	25	930	233
Dominican Republic	22	40	55	851	468
Ecuador	43	44	65	1405	913
El Salvador	6	56	71	884	628
Guatemala	39	61	73	1623	1185
Haiti	1	72	72	1433	1032
Jamaica	—	48	61	360	220
Mexico	25	27	23	7233	1664
Paraguay	32	53	68	657	447
Peru	53	30	76	2013	1530
Eastern and South-eastern Asia					
China	14	67	80	291451	233161
Indonesia	60	69	86	45071	38761
Myanmar	44	75	89	10495	9341
The Philippines	26	57	91	11324	9172
Thailand	25	77	77	15057	11594
Vietnam	26	78	88	17537	15433
Southern Asia					
Afghanistan	2	82	73	4205	3070
Bangladesh	6	84	83	30721	25498
India	17	73	84	204928	172140
Nepal	37	90	84	5384	4523
Pakistan	2	68	72	24003	17282
Sri Lanka	27	79	85	4753	4040
Western Asia					
Iraq	3	29	60	1550	930
Jordan	1	32	20	385	77
Lebanon	4	16	32	149	48
Syrian Arab Republic	1	50	33	1796	593
Turkey	11	39	48	7355	3530
Yemen	10	75	74	2609	1931

Source. UN 1995.

Table 4

Deforestation and time spent by women in gathering fuelwood

Country	Region, village, and forest status	Time collecting fuelwood (hours/day)
Africa		
Botswana	Eastern region	0.6
Burkina Faso	North Central region	
	Zimtenga village	0.1
		4.5
Egypt	Rural areas	0.2
Ethiopia	Southern Shewa Province	
	Sike Awraja	0.9
	Addis Ababa (serious fuelwood shortage in the area)	7.0
Ghana	Southern Zone	
	(a) Ashale Botwe (coastal savanna)	0.6
		0.8
	(b) Botianor (coastal savanna)	0.6
		0.7
	(c) Jankama, highlands	0.7
		0.5
Kenya	Galole Orma, Tana River district	
	(a) Nomadic Galole	0.1
	(b) Sedentary Galole (firewood scarce village)	0.7
	(c) Sedentary Chaffa (densely populated village)	1.6
	Eastern Province, Embu district	
	(a) Upper Embu	1.4
	(b) Middle Embu	0.8
	(c) Lower Embu	1.9
Niger		4.0
Nigeria	Forest Savanna Zone, Oyo State	
	(a) Oluwatedo Village	0.3
	(b) Ilora Farm Settlement	0.1
South Africa	Mahlabatani District, Kwazulu	
	(a) High grassland area (firewood shortage area)	1.3
	(b) Valley owveld area (comparatively accessible)	0.9
United Republic of Tanzania	Usambara Mountains of the North-east	
	Kwemzitu village	1.1

Contd...

Country	Region, village, and forest status	Time collecting fuelwood (hours/day)
	Morogoro region	
	Kikwawilla village	0.3
Zambia	Eastern Province	0.7
Asia		
	Northern region	
	Uttar Pradesh, Chamoli Hills	
	(a) Dwing (deforested)	5.0
	(b) Pakhi (deforested)	4.0
	Punjab, Ludhiana district	0.2
	Western region	
	Gujarat, Roli village (deforested plains)	4–5
	Eastern Hill region	
	Assam, Rajpara (forest-rich)	1.0
	South-western region	
	Maharashtra, Deokhop (restricted forest)	4.5
	Karnataka, Gulbarga district	0.4
	Raichur district	0.2
	Central Hilly region	
	Madhya Pradesh, Sehar (restricted forest)	2.2
Indonesia	Rural West Java	
	(a) Sumedang district	0.1
	(b) Ciamis district	2.0
Nepal	Western Hill region	
	Lowlands	
	(a) Low deforestation	1.1
	(b) High deforestation	2.5
	Highlands	
	(a) Low deforestation	1.9
	(b) High deforestation	2.6
	Mid-west region	
	Tinau Watershed Area	3.0
Pakistan		0.5
The Philippines		2.2
	Bukidnon Province, Mindanao	0.3
Yemen Arab Republic		3.0
Latin America		
Ecuador	North East Amazon	
	Napo and Sucumbios province	
	(a) <50% private forests cleared	1.0
	(b) ≥50%private forests cleared	1.2
Mexico	—	1.7–2.1

Contd...

Country	Region, village, and forest status	Time collecting fuelwood (hours/day)
Peru	Highland Peru	
	(A) Huancarama (access to rich stock private trees)	0.5
	(B) Pinchos (restricted forests)	1.3
	(C) Matapuquio (fuel-poor slopes)	1.7
	Puno in southern Andes	0.1

Source. UN 1995.

A series of energy studies conducted by the rural employment policy research programme of the International Labour Organisation (ILO) attempted to reduce the cost of observation studies of fuel and food consumption by using village women for data collection.

Even fairly long-term studies that concentrate on only one aspect of village life tend to inflate that activity in relation to another, since village women and men often do several tasks simultaneously. Should picking up twigs on the way to the fields to weed and again on the way back be classified as agricultural work or fuel gathering? If a baby is strapped on the mother's back, is that activity then child care? When men sit around and smoke but also make decisions affecting the village, is that leisure?

The combined picture of rural life that the few studies paint is one of long hours spent on repetitive, unskilled survival tasks; somewhat less time is spent in more skilled, income-generating activities, related primarily to food. In many countries, women spend more time than men in gathering fuel, though this is not true in forested areas of northern India, where men cut trees for fuel. Gathering water is also a problem everywhere, perhaps a greater problem than gathering wood in many countries. But everywhere, the main time-consuming activity is food processing.

Two surveys in East Africa indicate greater time spent in gathering firewood than revealed by earlier time-allocation studies. In Tanzania, women were found to spend up to 12 hours per week seeking firewood at a distance; women and children also pick up twigs while travelling to and from farm fields. Men did not assist in firewood collection. A study in Kenya found that women spent 30–60 minutes/day collecting firewood. Three-fifths of these families also had charcoal burners and used two types of fuel for different purposes. The wealthy farmers purchased charcoal, but in one-quarter of the households, the men

made charcoal for use and sale. Fetching water was more onerous than gathering firewood, with many households spending 5–6 hours/day of womens' and girls' energies on the former. Income differentials affect time distribution between men and women as well as between activities. In general, it seems that the poorer the family, the greater the number of hours worked by women and greater the importance of women's economic activity to family survival.

Coping strategies

In the past, cutting of wood fuel was itself considered a major cause of wood fuel scarcity and disappearance of forest resources: this is now widely agreed to be the exception. It is now accepted that the principal reason for deforestation and wood fuel scarcity is the clearing of natural forest-lands for agriculture. This is happening in almost all the African countries and other DCs like Brazil, Nepal, and parts of China (Energy Research Group 1986, FAO 1985).

Commercial logging for timber extraction is also a possible cause of forest destruction in some areas, but this usually has little, if any, direct impact on the domestic use of fuelwood. Cutting for charcoal and fuelwood to meet urban demands is, however, seriously depleting forest and woodland resources in some areas (Leach, Mearns 1988).

The emergence of wood fuel scarcity in an area is commonly described in terms of a wood fuel 'gap' between supply and demand which emerges as a result of rising consumption and falling levels of supply. This concept has heavily influenced thinking about wood fuel policies in the past 10 to 15 years, but has been coming under increasing criticism.

The weakness in the 'gap' concept is that it does not take account of the fact that people's fuel consumption and behaviour patterns are not fixed. In practice, consumption of a resource does not continue on an uninterrupted rising trend as the resource becomes scarcer. Instead, when wood resources become harder to obtain, people adapt ways that vary according to circumstances.

The first reaction is usually to economize on fuel. There are numerous ways in which this can be done and these are widely used throughout the developing world. Fires can be built in more sheltered places and shielded from draughts. They can be made smaller and kept lit for a shorter time. Greater care can be taken with the management of fires, and fuel can be quenched at the end of cooking to be reused instead of being allowed to smoulder away. Raising the overall cooking efficiency of an open fire with such simple measures

from 5% to 10 %, for example, would halve the amount of fuel consumed.

Changes can be made in cooking practices for example, pre-soaking some foods shortens the cooking time. In Nepal, greater use of uncooked food has been noted as a response to fuel scarcity, while in Guatemala, Mexico, Somalia, and Tanzania there has been a reduction in the consumption of those staple foods, such as beans, which require long cooking time (Leach, Gowen 1987). Similar observations have been made about the villagers of Nyamwigura in the Mara region of Tanzania, where beans that require three hours to cook have largely been substituted by rice and cabbage which require only 30 minutes.

People also turn to the use of alternative fuels. This generally takes place gradually rather than suddenly. Thus there is a shift from good quality fuelwood to smaller twigs and branches; agricultural residues also come into greater use. The cultural resistance to the use of dung is overcome and people begin to increasingly rely upon it as a fuel.

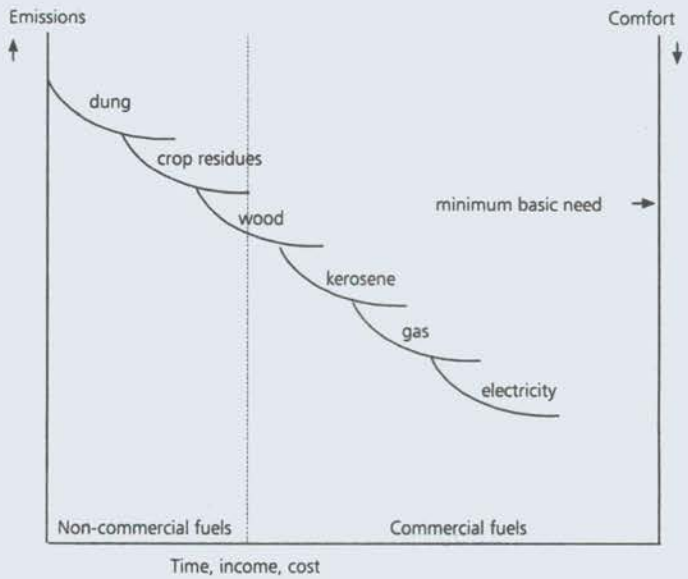
There is no doubt that the transition from the exclusive use of wood for cooking can cause considerable problems of adjustment for the families concerned. The alternative fuels are not as easy to use as wood and may require the development of new techniques of cooking and fire management. In some areas, for example, women dampen millet straw before using it in order to slow down the rate of combustion. But experience shows that though there may be strong initial resistance, the use of these fuels can become acceptable on a widespread basis. This has happened in some parts of the Indian subcontinent and China, where wood has long lost its position as the basic fuel of rural areas. In Africa, the number of areas where the transition has occurred is still limited, but it is likely to increase as time passes. Because these fuels are usually more abundant than wood fuel, and once they are in use, the problem of the physical availability of energy resources is, in fact, eased.

When people are no longer able to rely on an abundance of good quality firewood and the consequent absence of any need for economies, they are gradually forced to exercise care and frugality in the use of a variety of substitute fuels. As a result, a new equilibrium in fuel use is eventually reached. However, though people may be able to meet their household energy needs, there is no question that for many, it represents a lowering in the quality of their daily lives. Figure 1 illustrates the evolutionary path for cooking fuels and stoves in South Asia. In some cases, changes in income or availability of other resources may force some groups back up this path, but in general people prefer, if possible, to move downwards. Other fuels and paths

apply in other parts of the world and at other times in history. The point marked on the right vertical axis shows one possible definition of a minimum basic need of comfort, which could be defined as a combination of kitchen labour efficiency and cleanliness (Smith 1987).

In summary, across the world, biofuels are the most important fuels in terms of the number of people affected. In energy content, they are the most important fuels in many poor countries, although second to fossil fuels on a global basis. They are used principally at the household level for cooking and space heating. Further, they are likely to remain important for much of humanity for many decades.

Figure 1
The energy ladder



Source. Smith 1990.

Impacts of fuel scarcity on human health

The adverse effects of the use of traditional fuels on human health are not restricted to problems of air pollution alone. Each part of the fuel

cycle (production, collection, processing, and combustion) has its hazards, and this is listed in Table 5.

Table 5
The biofuel cycle and its impacts on health

Fuel cycle	Activity	Possible health effects
Production	Processing/preparing dung cakes	Faecal/oral enteric infections
	Charcoal production	Carbon monoxide(CO)/smoke poisoning
		Burns/trauma
		Cataracts
Collection	Gathering fuel	Trauma
		Reduced infant/childcare
		Bites from snakes, etc.
		Allergic reactions
		Fungus infections
Transportation	Transportation of biomass fuel	Backache
		Severe fatigue
		Damaged reproductive organs over time (prolapsed uterus)
Processing	Cutting up fuel	Trauma
		Cuts
		Abrasions
Combustion	Smoke	Conjunctivitis
		Acute respiratory infection (ARI), including pneumonia
		Cor pulmonale
		Adverse reproductive outcomes
		Lung cancer
		Higher rate of infant morbidity/mortality
		Depressed immune response
		Chronic obstructive lung disease (COLD):
		Chronic bronchitis
		Emphysema
		Asthma
	Toxic gases (CO)	Acute poisoning
		Low birth weight
		Higher rate of stillbirths
	Heat	Burns and scalds
		Cataracts
	Cooking position	Arthritis and related bone disease
		Back pain

Source. WHO 1992.

The time spent in the combined efforts of harvesting and cooking often consumes a significant fraction of the day. In addition, the decreasing availability of biofuels in many areas has resulted in an increase, and sometimes a shift, in the relative duration of these tasks because of the greater distances, that must be travelled to obtain these fuels and the decline in the average quality of fuels, which tend to increase the net weight of fuel to be carried and the cooking time (as well as smoke production). This creates several health-related problems, which are given below (Smith 1990).

- The inefficient use of women's working time, reducing the time spent on family care, and income-generating activities.
- The appropriation of children's time that might otherwise be occupied in more productive or educational pursuits.
- Pressure on cooking patterns leading to practices that may lower nutritional status such as reducing the number of meals per day, the type of food preparation, the thoroughness of cooking, or the kind of food cooked.
- Women and children may be encouraged to shoulder physical loads of an unhealthy size and quantity.
- Additional food energy is required for the least well-nourished family members i.e., women and children.
- The loss of household income-generating opportunities from food preparation and other fuel-using enterprises may result. Studies have shown that such income, particularly when earned by women, is often important in maintaining family nutrition and access to health care.
- Household income may be lowered by encouraging the use of more expensive pre-prepared foods (as well as purchase of alternative fuels).
- Boiling water, cleaning, bathing, and other activities necessary to maintain a sanitary home may be discouraged.
- The risk of increased rates of malaria, infections from injuries and parasites (such as leeches) or urinal victimization of women and children forced to forage in marginal areas.
- The possibility of decreased efficiency and increased ill health resulting from inability to heat homes properly in upland or temperate areas.
- Male migration may be encouraged, leading to an increase in the already usual double burden on women (home and farm).

The household coping strategies due to shortage of fuelwood listed and their consequences are listed in Table 6. However, this report focuses on the ill effects of exposure to smoke.

Table 6
Household coping strategies and impacts on nutrition and health

Coping strategies	Impacts on nutrition and health
1. More time is spent on collecting fuelwood	1. Fuel harvesting leads to: • increased caloric needs, • increased risk of assault and injury, and • increase risk of natural hazards
2. Fuelwood is substituted either by • inferior biomass fuels, or • commercial fuels.	2. Cooking with inferior biomass fuels leads to: • increased air pollution, • increased tending time, and • decreased consumption of those items of food that require long periods of cooking
3. Fuelwood consumption is reduced by cooking less.	3. Food supply is affected in the following ways: • decreased food production, • decreased food purchase, and • decreased food preservation and storage. 4. There is less time for • income-generating activity; • resting; and • space, water heating, and other hygiene-related activities. 5. Food preparation and distribution is affected in the following ways. • food is prepared less often, • more food is consumed by warming up food previously cooked, and • the special food that children and pregnant/ lactating women require is prepared less often.

Source. WHO 1997

Cooking-related exposure

Although there are numerous separate chemical agents that have been identified in biofuel smoke, the most emphasized four are: particulates, CO, polycyclic organic matter, and formaldehyde. These four pollutants can be treated as the main indices of biofuel smoke. Unfortunately, relatively little monitoring has been done in village and slum indoor environments in a statistically valid manner. The results, nevertheless, are striking (Table 7). The concentrations are ten to hundred times higher than the health-related standards/guidelines. Rest of the discussion in this chapter will be restricted to particulate

Table 7

Typical concentration levels of total suspended particulate (TSP) matter indoors from biofuel combustion in developing countries

Country	Year	Sample size	Conditions	Concentration ($\mu g/m^3$)
I Area concentrations				
Papua New Guinea	1968	9	overnight, floor level	5200
	1974	6	overnight, sitting level	1300
Kenya	1971/72	8	overnight, highlands/ lowlands	4000/800
	1988	64	24h, thatched /iron roof	1300/1500 (R)
India	1982	64	30 min. wood/dung/charcoal	15800/18300/ 5500
	1988	390	cooking, 0.7m/ceiling	4000/21000
	1992	145	cooking/non-cooking/living	5600/820/630
	1994	61	24h, ag-resid/wood	2800/2000 (I)
	1995	50	Breakfast/lunch/dinner	850/1250/1460 (I)
	1996	136	Urban, cooking/sleeping	2860/880 (I)
Nepal	1986	17	2 h	4400 (I)
China	1986	64		2570
	1987	4	8 h	10900 (I)
	1988	9	2 houses, 12 h	2900
	1988	12	4 houses, dung	3000 (I)
	1990	15	Dung, winter/summer	1670/830 (I)
	1991		Straw, avg. summer-winter, kitchen/living	1650/610/1570(I)
	1991		Single storey/double storey houses	80/170
	1993	4		1060 (I)
Gambia	1988	36	24 h, dry/wet season	2000/2100 (I)
Zimbabwe	1990	40	2 h	1300 (I)
Brazil	1992	11	2–3 h, trad./impr. stove	1100/90 (I)
Guatemala	1993	44	24 h, trad./impr. stove	1200/530 (I)
	1996	18	24 h, trad./impr. stove	720/190 (I), 520/ 90 (I)
	1996	43	24 h, trad./impr. stove	870/150 (R)
S. Africa	1993	20	12 h, kitchen/bedroom	1720/1020
Mexico	1995	31	9 h	335/439 (R)/(I)
II Personal monitoring				
India	1983	65	4 villages	6800
	1987	165	8 villages	3700
	1987	44	2 villages	3600

Contd...

Country	Year	Sample size	Conditions	Concentration ($\mu g/m^3$)
	1988	129	5 villages	4700
	1991	95	winter/summer/monsoon	6800/5400/4800
	1996	40	two urban slums, infants, 24 h	400/520 (I)
Nepal	1986	49	2 villages	2000
	1990	40	Trad./impr .stove	8200/3000
Zambia	1992	184	4 h, urban, wood/charcoal	470/210 (R)
Ghana	1993	43	3 h, urban, wood/charcoal	590/340 (R)
S. Africa	1993	15	12 h, children, winter/summer	2370/290

Source. Smith 1996.

I–inhalable particulate matter ; R–respirable particulate matter

The WHO guideline is 100–150 $\mu g/m^3$.

matter, because of data gaps regarding other pollutants, and also the fact that particulate matter is one of the most common and harmful of pollutants.

The health damage caused by air pollution is dependent on the dose received by the population in question. Because the dose is difficult to determine for large number of people, air pollution studies have tended to focus on exposure, which is usually assumed to be closely proportional to dose. In practice, however, a surrogate for exposure, i.e., ambient concentration, has actually been measured in most instances. This has been done, for example, by placing monitoring instruments on the roofs of public buildings in urban areas. This practice assumes that the overall ambient concentration is well characterized by the particular choice of places and times that measurements are made and that actual human exposures nearby are proportional to the ambient concentration so determined. In fact, Smith (1993) has estimated that only two per cent of all people's time is spent outdoors in developed country cities where the bulk of air pollution control efforts have taken place.

There are few microlevel studies that attempted to measure actual exposure levels in communities using biofuels. The first such study done in a rural hilly area of India concluded (Table 8) that the daily exposure levels of women and children far exceed comparable Indian or international standards and those of youth and men (Saksena et al. 1992).

Table 8
Mean daily integrated exposure to TSP (mg/m^3) in a rural hilly area of India

Season	Women	Children	Youth	Men
Winter	1.96	1.04	0.79	0.71
Summer	1.13	0.54	0.33	0.25

Note. Daily Indian standard for residential areas is 0.1 mg/m^3. The World Health Organization (WHO) guideline is 0.10–0.15 mg/m^3.
Source. Saksena et al. 1992.

More interesting results have emerged from a survey of 80 urban households in two slums of Delhi – one in an area with high ambient pollution and the other in a comparatively cleaner area (Saksena et al. 1997). The researchers in each slum, measured daily exposure in two groups – one using wood and the other using kerosene. The daily integrated exposure to respirable suspended particulates (RSP) was high for wood using group in the highly polluted slum for both women and infants. It was in the range of 12–19 mg h/m^3 for infants in wood using houses, and 12–14 mg h/m^3 for infants in kerosene using houses. Comparing these figures with the WHO recommendations (1.2–3.0 mg h/m^3), it was noted that the daily exposure of infants to RSP in wood and kerosene using houses is 10–16 and 10–12 times the WHO limit.

It was observed that in the case of infants, the cooking micro-environment contributes 11% to the total daily exposure for kerosene users, and for wood users it is higher at 14%. The same in the case of women was 15% for kerosene users and 21% for wood users. For infants and women, the maximum contribution came from sleeping indoors and indoor background micro-environments. The exposure of women due to cooking was significantly higher in wood using households. The total exposure of women and infants to RSP was well correlated. But the exposure during cooking period of women and infant was not strongly correlated. The daily integrated exposure of infants and women to RSP was poorly correlated with the outdoor levels. Thus, the outdoor (near ambient) RSP levels not only underestimate the magnitude of daily exposure, but are also not satisfactory in explaining or predicting the variability in the exposure. Though the RSP concentration during cooking is less in kerosene using houses as compared to wood using houses, the exposure during the same period is similar. This is because of three factors.

1. Daily cooking time is greater for kerosene using houses as compared to wood using houses
2. The fraction of total cooking time actually spent near the fire by the infant is also higher in kerosene using houses.
3. Most kerosene users cook indoors along with their infants close by, while wood users cook outdoors keeping their infants outdoors or indoors depending on the season.

The estimation of exposure at a global level requires a good database of time-activity patterns, which does not exist at the moment. Therefore, we are compelled to extrapolate from the few surveys that have been conducted in rural areas. Also, a comprehensive risk assessment would entail comparing the exposure across groups and comparing indoor exposure with outdoor exposures. Table 9 gives data on RSP concentration for some of the major micro-environments in the developed and the developed regions of the world.

Table 9

RSP matter concentration in major global micro-environments

Region		Concentration ($\mu g/m^3$)		
		Cooking	Indoor	outdoor
Developed	urban	400	60	40
	rural	500	50	30
Developing	urban	500	200	150
	rural	800	300	100

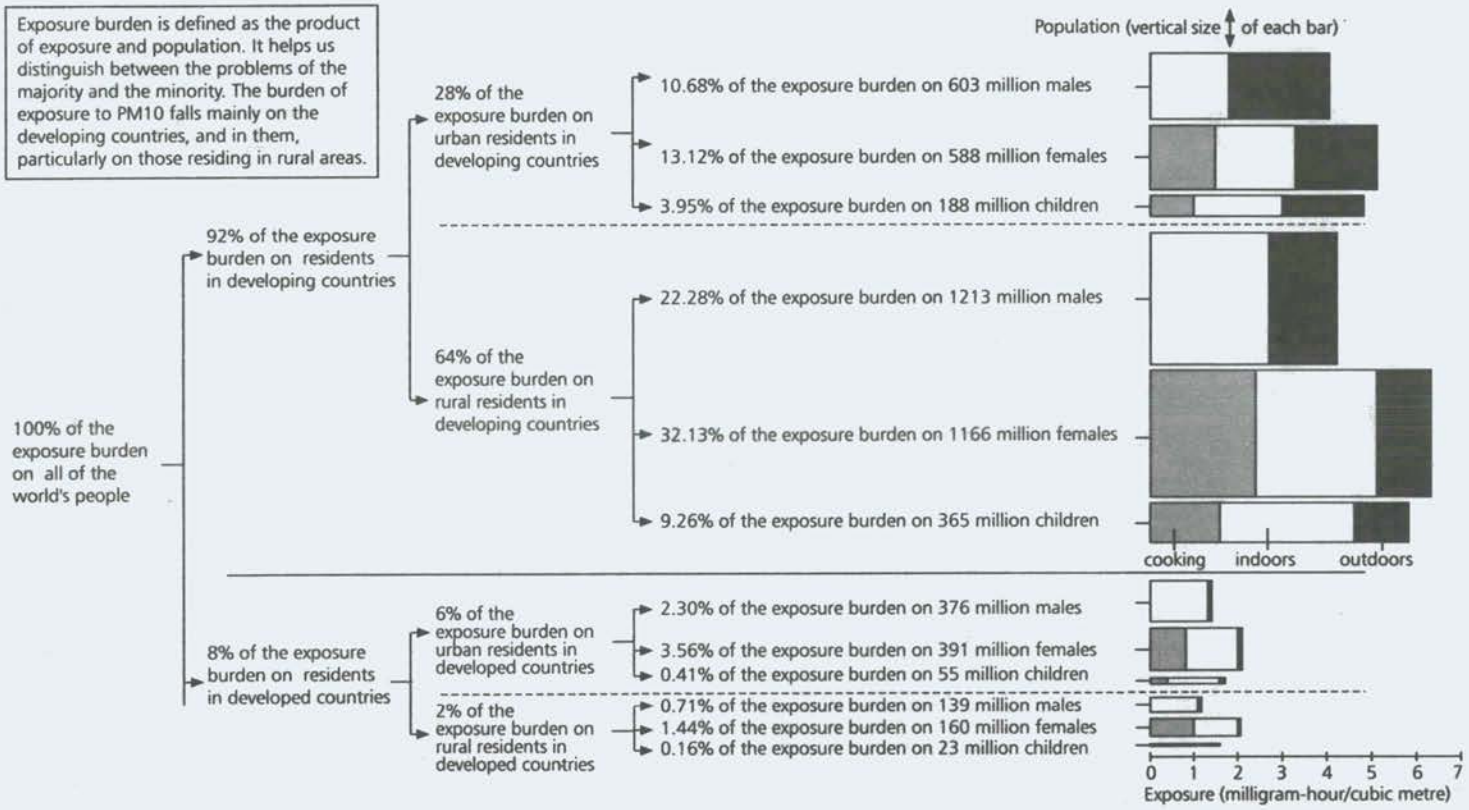
Note. Data estimated from TSP values used by Smith (1993), assuming that RSP in a particular micro-environment is a certain fraction of TSP.

The global exposure has been estimated on the basis of typical pollutant levels (concentrations) in the micro-environments, the time spent by various population groups in these micro-environments, and the size of these groups. The exposures in these micro-environments are shown in Figure 2. Globally, cooking contributes about 23% to the exposure burden, while outdoor pollution accounts for 29%. While adult women account for 44% of the world's population, their share of exposure burden is 50% (Figure 2). The DCs bear 92% of the global exposure. A sensitivity analysis of the data indicates that a reduction in the concentration of RSP to 10% during cooking in rural and poor

Figure 2

Distributions of global exposure burden

Exposure burden is defined as the product of exposure and population. It helps us distinguish between the problems of the majority and the minority. The burden of exposure to PM10 falls mainly on the developing countries, and in them, particularly on those residing in rural areas.



urban areas of the DCs will result in 2% reduction in the global exposure. On the other hand, reducing outdoor pollution concentration all over the world by 10% would reduce the global exposure by only 1%.

Health effects of indoor air pollution

The total human exposure to many important pollutants is much more substantial in the homes of the poor in DCs than in the outdoor air of cities in the developed world, because of the high concentrations and the large population involved. However, it is the outdoor problem that has received the most attention in the form of air pollution research and control efforts (Smith 1988). As a result, it has been necessary to extrapolate from the urban studies to estimate what the health effects might be in households using biomass (de Koning et al. 1985, Smith 1987). In recent years, however, there have been some studies which directly focus on these households and which generally confirm what has been extrapolated (Chen et al. 1990). Given below are brief summaries of the major health effects, as initially documented by WHO (1992).

Acute respiratory infections in children

Acute respiratory infections as pneumonia, is one of the chief killers of children in DCs. At 4–5 million deaths per year, it is equal to or marginally less than the deaths caused due to diarrhoea (Monto 1989, Leowski 1986). ARI in general is also responsible for more episodes of illness than any other disease category. It is well known to be enhanced by exposure to urban air pollutants and indoor environmental tobacco smoke at levels of pollution that are some 10–30 times less than that typically found in village homes.

The first published study of the association between ARI and woodsmoke in young children was based on examinations of 1150 infants in a hospital in South Africa (Kossove 1982). Significant number of children who lived in homes using wood-fire found to have symptoms of ARI. A number of detailed studies were initiated in the mid-1980s. One study that focused on school-age children in Malaysia found no relationship with the use of a wood stove, but did find increased prevalence of symptoms with the use of mosquito coils (Azizi, Henry 1991). This negative result is similar to that of an earlier

study in Papua New Guinea which also worked with school-age children, who had much lower rates of serious ARI than children under five years (Anderson 1978). The only study to actually measure air pollution levels was done in Kenya, but unfortunately this had resources to examine only 36 households (Wafula et al. 1990). They found high levels of pollutants in all of the houses, with little variation; thus it was not surprising that they found no association with ARI rates.

The most interesting studies now available were done in Nepal, Zimbabwe, and Gambia. The Nepal study did a weekly examination of about 240 rural children under two years for six months for incidence of moderate and severe ARI (Pandey et al. 1989). They found a strong relationship between the reported hour (by the mother) per day the children stayed by the fire and the incidence of moderate and severe cases. In Zimbabwe, 244 children under three years reporting at the hospital were compared to 500 similar children reporting to a clinic (Collings et al. 1990). Presence of an open wood-fire was found to be a significant ARI risk factor. In a study of 500 children in Gambia, girls under five years carried on their mothers' backs during cooking (in smoky huts) were found to have six times greater risk of ARI, a substantially higher risk factor than parental smoking. There was no significant risk, however, in young boys (Armstrong, Campbell 1991).

A study in Buenos Aires (Cerqueiro et al. 1990) used a matched case-control method to identify risk factors for acute lower respiratory infection (ALRI) in 670 children. The results of the study indicated a high odds ratio (OR) with respect to indoor contaminants.

Penna and Duchiade (1991) examined the relationship between air pollution measured as TSP and infant mortality due to pneumonia in the TSP metropolitan area of Rio de Janeiro. They found a 2.2/1000 increase in mortality per 100 $\mu g/m^3$ increase in annual TSP concentration. Though the study did not focus on biomass smoke, this risk if valid, would imply a high burden of fatal infant pneumonia from smoke in many villages.

In a nine month study of ALRI, the short-term prognostic implications of socio-economic and household risk factors were examined in 103 hospitalized pre-school Nigerian children. A highly significant association was seen between household cooking fuel and the outcome of hospitalization: 63% who died were potentially exposed to woodsmoke (Johnson, Aderele 1992).

A case-control study was undertaken in a rural area of Gambia to evaluate the risk factors for death from ALRI in young children. On

the basis of post-mortem interviews, 129 children aged one to two years were thought to have died from ALRI. These cases were matched (according to age, sex, ethnic group, time, and place of death) with a child who had died from a cause other than ALRI and with two living children as control. Comparisons suggested that exposure to smoke during cooking and parental smoking were associated with an increased risk of death from ALRI (de Francesco et al. 1993).

Four hundred children under five years of age in South Kerala, India were studied to identify risk factors for severe pneumonia. Cases were in-patients with severe pneumonia as ascertained by WHO criteria, while controls were out-patients with non-severe ARI. Cooking smoke was not identified as a significant factor (Shah et al. 1994).

O'Dempsey et al. (1996) investigated possible risk factors for pneumococcal disease among children living in a rural area of Gambia. A prospective case-control study was conducted, which indicated an increased risk of pneumococcal diseases associated with the child being carried on mother's back while cooking.

A recent study of 642 infants conducted in urban slums of New Delhi, India examined the relationship between incidence of ALRI and indoor air pollution. The study was conducted in two slums – one in a highly polluted area and the other in a less polluted area. In each slum, infants from households using wood and kerosene were chosen. The incidence of ALRI in households using wood was not found to be significantly higher than in those using kerosene. However, the reasons have yet to be fully examined (Sharma et al. 1998).

These studies are extremely suggestive, but do not yet allow quantified conclusions because ARI has so many other risk factors, which are difficult to account for.

Adverse pregnancy outcomes

Low birth weight (LBW), a chronic problem in DCs, is associated with a number of health problems in early infancy, as well as other negative outcomes such as neonatal death. Several risk factors are associated with LBW, most notably poor nutrition. Since active smoking by the mother during pregnancy is a known risk factor and exposure is suspected, there is also cause to suspect biomass smoke as it contains many of the same pollutants. Studies in Guatemala (Dary et al. 1981) and India (Behera et al. 1988) found substantial amounts of CO in the blood of women cooking with biomass, and this was

found to be the most probable cause. Another study in India found that pregnant women cooking over open biomass stoves had almost 50% greater chances of stillbirth (Mavalankar 1991).

Chronic obstructive pulmonary disease and cor pulmonale

Chronic obstructive lung disease, for which tobacco smoking is the major risk factor remaining in the DCs, is known to be an outcome of excessive exposure to air pollution. It is difficult to study because the exposures that cause the illness occur many years before the symptoms are seen. Nevertheless, there were studies in Papua New Guinea (Anderson 1979), Nepal (Pandey 1984), and India (Malik 1985; Behera, Jindal 1991) which led the investigators to conclude that nonsmoking women who have cooked on biomass stoves for many years exhibit a higher prevalence of this condition than might be expected or than similar women who have made lesser use of biomass stoves. In rural Nepal, nearly 15% of nonsmoking women (20 years and older) had chronic bronchitis, a high rate for nonsmokers.

Cor pulmonale (heart disease secondary to chronic lung disease) has been found to be prevalent and develop earlier than average in nonsmoking women who cook with biomass in India (Padmavati, Arora 1976) and Nepal (Pandey 1988).

A cross-sectional survey based on population was conducted to determine the prevalence of chronic bronchitis and associated risk factors in an urban area of Southern Brazil. 1053 subjects aged 40 years and above were interviewed. High level of indoor air pollution (OR = 1.86) was found to be associated with increased prevalence of the disease (Menezes et al. 1994).

In Saudi Arabia, it was discovered that 66% of the women with chronic obstructive pulmonary diseases (COPD) and only 5% of the women without COPD had been exposed to indoor open fire for more than 20 years (Dossing et al. 1994).

Dennis et al. (1996) investigated the role of firewood smoke and other indoor pollutants as a potential risk factor for obstructive airways disease (OAD) among women in Bogota, Columbia. Two hundred and eight subjects were chosen for the study. Univariate analysis showed that tobacco use, wood use for cooking (OR = 3.43), and passive smoking were associated with OAD.

In Mexico, a case-control study was performed in women older than 40 to evaluate the risk of cooking with traditional wood stoves

for chronic bronchitis and chronic airway obstruction (CAO). Exposure to woodsmoke, assessed as any or none, and as hour-years (years of exposure multiplied by average hours of exposure per day) was significantly higher in cases than in controls. Differences in exposure to woodsmoke persisted after adjusting by stratification and logistic regression for age, income, education, smoking, place of residence, and place of birth. Risk of chronic bronchitis alone and chronic bronchitis with CAO increased linearly with hour-years of cooking with a wood stove. The findings support a causal role of domestic woodsmoke exposure in chronic bronchitis and CAO (Perez-Padilla et al. 1996).

Cancer

There are many chemicals in biomass smoke, which are carcinogenic in nature (Cooper 1980). In the 1970s, a small study in Kenya, suggested that pharyngeal cancer might be associated with biomass smoke (Clifford 1972), but newer studies in Malaysia (Armstrong et al. 1978) and Hong Kong (Yu et al. 1985) have failed to confirm this. Based on risk extrapolations from animal studies, lung cancer, which might be expected to be common in biomass-using areas is relatively rare (Koo et al. 1983). Indeed, some of the lowest lung cancer rates in the world are found in rural nonsmoking women in DCs. This is somewhat of an anomaly, and can only be partly explained by poor health records. A recent study in Japan (Sobue 1990) on the other hand, found that women aged 30 years old cooking with straw or wood fuel have an 80% increased chance of having lung cancer in later life (cancer, like chronic lung disease, takes many years after exposure to develop).

Compared to biomass, there are many studies on air pollution levels and health impacts of cooking with coal on open stoves, almost all done and published in China, where coal is commonly used for cooking (Hong 1991). A range of effects are found including very strong associations with lung cancer. Even in China, however, biomass use is much more prevalent, but has not yet received adequate scientific and policy attention.

Two hundred female lung cancer patients and 200 female district controls in Hong Kong were interviewed about their earlier use of various types of cooking fuels to assess whether any association could be found with lung cancer. Mixed results were found when the data was analysed in terms of ever-exposed versus never-exposed duration, and relationship with smoking (Koo et al 1983).

In Xuan Wei county, Yunnan Province, China, a quantitative risk assessment study of indoor air pollution indicated an obvious on-site exposure–response relationship between benzo(a)pyrene concentration in indoor air and lung cancer mortality. The case-control study showed that in females, the presence of lung cancer is statistically associated with chronic bronchitis and family history of lung cancer. The results also suggested an association of lung cancer with the cooking duration, but not with passive smoking (He et al. 1991)

Recently, Koo and Ho (1996) concluded that diet can be an important confounding factor affecting lung cancer risk estimates from air pollution exposures among Chinese women living in an affluent urban environment. There is also evidence that fluorine in coal can be absorbed in food, causing health problems (Ando et al. 1998).

Tuberculosis

One of the most disturbing implications of recent research is that woodsmoke may be potentially associated with tuberculosis. A large-scale survey in India reported that women using biofuels were three times more likely to have tuberculosis than women using cleaner fuels, even after accounting for a range of socio-economic factors (Mishra et al. 1997 a).

Blindness

A case study in India found an excess cataract risk of about 80% among people using biofuels (Mohan et al. 1989). Again, in India, a large scale family survey found a somewhat lower rate for partial blindness (OR = 1.30), but no significant difference for total blindness (Mishra et al. 1997 b).

Health impacts

There is growing scientific evidence to support the numerous anecdotal accounts relating high biomass smoke levels to important health effects. Based on such studies and drawing from western experience and data, WHO has estimated that 2.7–3.0 million deaths (six per cent annual global deaths) occur due to indoor and outdoor air pollution. Using one methodology, it has been estimated that about 3 million premature deaths are due to air pollution, and 2.8 million due to indoor pollution. It has been estimated that the largest

number of deaths will occur in India, followed by Sub-Saharan Africa (WHO 1997). As regards deaths due to indoor exposure, 90% of them will occur in DCs.

Knowledge gaps and needed research

A high priority in research is to conduct epidemiological studies to identify the relationships between ARI, indoor air quality (biomass smoke and tobacco smoke), nutritional status, other infections, family/household composition, socio-cultural variables, and so on.

The possible research strategies for epidemiological studies identified WHO (1992) are listed below.

- Case control studies to establish relationships, identification of dose-response and dose-effect relationships. Some studies have been done but more are needed.
- Studies of 'natural experiments' in which incidence rates of episodes might be examined longitudinally in relation to changes such as introducing stoves with chimneys in dwellings previously lacking chimneys.
- Studies in which health status is assessed with and without interventions such as improved stoves.

All such studies, of course, should meet accepted scientific standards for quality control and ethical conduct. Case control and cohort studies can also be used for examining possible relationships between smoke exposure and reproductive outcomes.

A variety of multi-disciplinary research strategies will be required to clarify and delineate these and chronic effects. Case-control studies could help establish causal relationships for COPD and cancer, although one must be aware of potential sources of bias and confounding variables. Cohort studies of populations containing groups exposed to varying and known levels of indoor smoke have the potential to allow more quantified inferences to be made. For example, large populations could be observed for prolonged periods. A retrospective cohort design might be feasible if a suitable setting and data exist.

Case-control studies can be a suitable method to examine the relationship between radiant heat and cataract, with careful consideration of confounding variables. Since the potential health effects of biomass smoke are common to all DCs, and influenced by numerous risk factors, epidemiological studies in many different

settings should be encouraged. Experience in other settings, however, has shown that it is difficult and often unrewarding for international collaborative studies to attempt exact replication of methods and procedures. It is probably wiser to encourage variation of study design, methods, and procedures according to local environmental, demographic, and cultural conditions, recognizing that these variables are 'fixed' in any given setting, rather than susceptible to manipulation to fit a common underlying research design.

It is, however, important for different laboratories and research teams to collaborate in the development of similar methods to measure exposure and health effects, incorporating inter-laboratory quality assurance procedures in order to make the results as comparable as possible. For example, pulmonary function test results could be compared among study sites, using standardized instruments and quality assurance procedures.

In order to maximize scarce resources, research should, where-ever possible, be linked to existing research projects that have already gathered some of the crucial information on ARI or other outcomes in the target groups (examples include vitamin A deficiency and family planning projects).

Work is needed to improve the quality of existing data and facilitate the collection of new data. The most accurate available indicator of indoor air pollution is personal and area monitoring for RSP. Further work is required, however, to improve the capacity to simply and quickly assess exposure to indoor air pollution. In the case of particulates, it is necessary to gain a better understanding of the indoor sources other than cooking (such as re-suspension and building materials) and the relationship between indoor and outdoor air quality levels. It is difficult to assess exposure in children aged two to five years with existing methods; time-weighted area monitoring might be the best choice. There is also the possibility of utilizing appropriate biological markers, which is another research priority.

Epidemiological, toxicological, engineering, environmental, and anthropological research in this area should be directly coordinated. The combined effect of a multidisciplinary approach greatly enhances the power of research and produces results that can be acted upon.

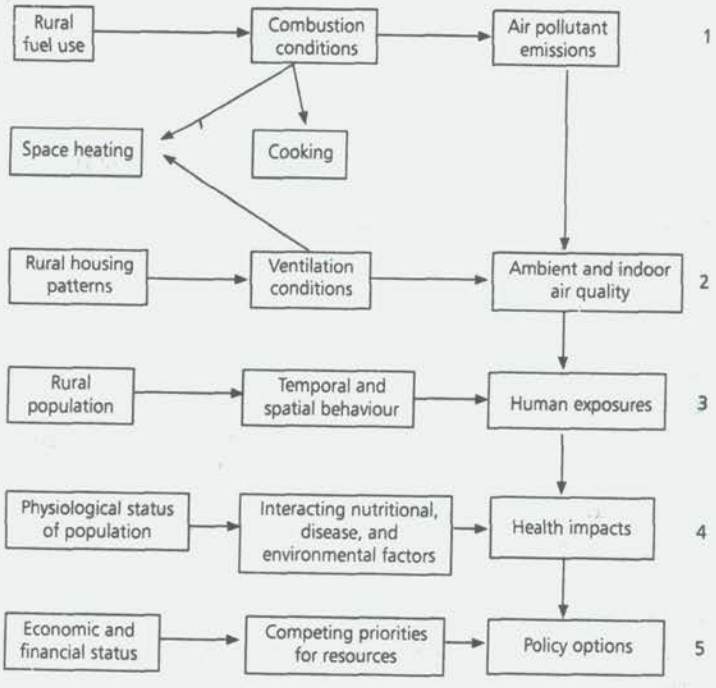
The research priorities include epidemiological studies to confirm the causal relationship of biomass emissions to ARI (very high priority); on adverse reproductive outcomes (high priority); on COPD (high); and various other health outcomes specified above. A powerful application of epidemiological methods lies in the evaluation of interventions, such as the provision of improved stoves.

Interventions, policies, and social aspects

Interventions can occur on many fronts, as shown in Figure 3. Ever since the oil crisis of the 1970s, more attention has been paid to solving problems related to conventional, fossil fuel energy activities. Yet, the energy problem directly facing most of the humanity has remained unnoticed and ignored. The challenge facing most societies is how to sustainably manage the biomass energy transition – the transition from traditional forms of biofuels to modern fuels of development including modern forms of biofuels.

There are basically two aspects of the transition. Firstly, there is a need to find sustainable means to harvest biofuels for the needs of that majority of humanity now relying upon them. Secondly, there is a need to develop high-grade biomass fuels that can meet development requirements, and improve efficiency, controllability, and cleanliness of end-use devices. These efforts comprise a subset of programmes

Figure 3
Factors affecting the indoor air pollution problem



Source. Smith 1987.

designed to assist villagers themselves acquire the means to improve welfare and provide basic necessities.

Fuels

In the past, rural development was typically accompanied by a transition from traditional biofuels to fossil fuels, particularly kerosene, diesel oil, and liquefied petroleum gas (LPG). It is recognized now, however, that the cost and insecurity of today's petroleum supplies may delay or deny this transition in many of the now DCs. The cost required to provide alternate energy sources such as natural gas, kerosene or solar cookers to the millions of households using rural biofuels would be very large.

In the short term, it appears that the economic and logistic barriers to meeting rural energy needs solely with fossil fuels will be unsurmountable. This implies that biofuels will have a continuing role for many decades and must be considered immediately by policy-makers if the behaviour of the entire national energy system is to be understood and manipulated. If biofuels are to provide the type of energy services previously accomplished by petroleum fuels, there must be substantial changes in the form and use of these fuels. So dramatic are these changes that it is appropriate to call them part of the post-biofuel transition, or, more accurately, the post-traditional biofuel transition. This transition is occurring at every stage of the biofuel cycle, i.e., from harvesting through conversion to end-use (Smith 1986).

At the production stage, a change is occurring from unplanned and unscientific practices of gathering biofuel to sustainable harvesting. At the conversion stage, a number of processes are becoming available to upgrade the relatively low-grade natural solid biofuels into high-grade solid, liquid, and gaseous fuels that can fuel a wide range of tasks beyond the basic necessities of cooking and space heating that biofuel now provides. More importantly, equipment is now being developed to accomplish these conversions at village and household scale. Examples are biogas and producer gas devices, alcohol fermentation, and charcoal manufacture. Some of these conversion processes have an additional advantage in that they remove the most polluting step out of the household to a village-level or otherwise to a more centralized location. This can greatly reduce individual exposures even if total emissions are not reduced.

It appears unlikely that a large fraction of households that rely mainly on traditional biofuels will be able to switch over to better

energy systems in the near future. A quick and direct transition to fossil fuels also does not seem feasible. In a few decades, it is possible that households could switch over directly to modern forms of biofuels, provided that technical progress and the required institutional changes are set in place early enough.

If biofuels continue to retain their importance during rural development and are not rapidly and extensively replaced by fossil fuels, the human air pollution exposures that result from their use must be addressed directly in rural energy policy. This will involve, for example, explicit consideration of the emission factors of alternative biofuels and the relative impacts of processes for conversion of biomass to upgraded fuels such as charcoal, gasification, etc. The ultimate target of planners should be to achieve a 'win-win' situation in terms of energy and environment objectives.

Stoves

In the short and medium term, increasing the efficiency of use of biofuels seems to be the only feasible option. Changing fuels is only viable over the long term. Till recently, research on stoves and implementation programmes considered fuel savings as the sole objective behind improvements. The relationship between various parameters that govern stove performance are very complex and ill understood. More importantly, given these complexities, trade-offs between desired objectives had to be considered. Nevertheless, research can lead to the development of cooking systems that are so efficient that overall exposure can be reduced, while ensuring an optimal thermal performance and social acceptability.

Large-scale acceptance of improved stoves would require a concerted effort on the part of local organizations and governments in individual countries to mass-produce them, in a participatory manner, and overcome the social resistance to change. Currently, all the improved stove designs are aimed either at increasing fuel efficiency or at removing smoke from the house via a chimney or flue. A few try to accomplish both goals. Few, however, attempt to modify the combustion conditions in such a way that both efficiency and low emissions are achieved. It can be argued that providing a flue to take the smoke from the room is sufficient, although many improved designs do not incorporate this feature. However, the most important barriers to new stove introductions are not technical but social (Smith 1987).

Many contradictory opinions and uncertainties still remain about the best ways to disseminate stoves, after assuming that a good design

has been achieved. Reliance on a market encouraged by the government has certain attractions while a welfare approach seems to be necessary for many of the poorest groups. The extent to which high-quality devices benefiting from the quality control possible with mass-production are better than devices individually tailored for local conditions is also a part of an ongoing debate (Smith, Ramakrishna 1986).

The social barriers to stove implementation are the most difficult, and thus before attacking them it would do well to be careful to first design the best stove possible. This would be a stove that accomplishes both efficiency and emissions goals. Otherwise, there is the risk that after going through the considerable implementation effort required to disseminate a new stove of one type, it may be necessary to come back in a few years and try to disseminate an entirely different stove.

A similar problem has been confronted in smokeless stove programmes in some DCs. Some smokeless stoves were found to require more fuel than traditional models, earning them a poor reputation and making further introduction of new stoves difficult. In other cases (Smith et al. 1983), smokeless stoves failed to reduce smoke exposures substantially, making difficult the acceptance of additional stoves in the neighbourhood. The two goals – high thermal efficiency and low exposures – should be approached in parallel and in a deliberate manner such that false expectations are not generated. It is far better to have stoves perform better than advertised, than to generate ill-will by a too hasty and ambitious effort.

Stove design programmes are of two basic types, those aimed towards developing improved stoves that can be constructed locally nearly entirely out of local materials, and those programmes directed towards mass production of improved designs using metal and other materials; not usually available in the poorest rural areas. Both types must seek inexpensive and durable designs that are suited to local fuels, housing, and cooking patterns. Mass-produced stoves can be designed under fewer materials constraints but must also account for transport. Locally-made stoves can, in some cases, be designed to be made by the family, eliminating or greatly reducing cash outlays. There are good arguments for each approach under different circumstances. Income levels and the extent of cash markets are two of the many variables that would help determine which approach is best in a particular area. In addition, some stoves seem to require fairly strict quality control in manufacture, arguing for mass production

(Baldwin et al. 1985). Data on cost and efficiency of alternative cooking stoves is shown in Table 10.

Table 10
Cost and efficiency of alternative cooking technologies, 1991

Stoves	Efficiency		Stove capital cost
	Stove (per cent)	System (per cent)	(US $)
Traditional			
Dung	11–15	10–14	—
Agricultural residues	13–17	12–16	—
Wood	15–19	14–18	—
Wood (Commercial)	15–19	14–18	—
Charcoal	19–23	8–12	3
Improved biomass			
Wood	27–32	26–31	6
Charcoal	29–34	13–17	8
Wood II	40–44	38–42	10
Liquid			
Kerosene wick	40–45	36–41	20
Kerosene pressure	45–50	41–45	40
Alcohol wick	40–45	33–37	20
Alcohol pressure	45–50	37–42	40
Gas			
Central gasifier	55–60	39–42	20
Site gasifier	40–45	39–44	50
Biogas	55–60	54–59	20
LPG	55–60	48–53	50
Natural gas	55–60	53–58	20
Electric			
Resistance	60–65	17–21	75
Microwave	55–60	16–20	250
Solar			
Solar box oven	25–30	25–30	25

Source. WRI 1994.

Housing improvements

In addition to changing the fuel or the stove, another option for reducing air pollutant levels is to improve the ventilation where the fuel is being used. The easiest solution in principle would be to move the cooking activity outdoors and locate the stove downwind from the cook or other persons nearby. Climatic conditions such as heat, cold, winds, and rain can make this approach impractical for much of the year. In addition, village social conditions, such as interference by village animals, may be part of the reason why cooking is done indoors in the first place. The need for privacy, or other cultural reasons may also be obstacles to moving the cooking activity outdoors. Nevertheless, cooking is done outdoors, or in very well-ventilated covered kitchen houses or verandahs in many parts of the world. Such practices could be encouraged in other areas although clearly such a shift would not be possible in cold upland areas. The role of ventilation in determining exposure levels was studied in a recent survey of 80 households in two slums of Delhi. It was discovered that the exposure due to cooking in kerosene using households is as high as that of wood using ones mainly because, the former usually cook indoors while the latter cook outdoors (Saksena et al. 1997).

If biofuels are to be in use in rural areas for many years, then consideration should be given to changing the design for new rural housing units to improve ventilation in the kitchen area. The stove and cooking area might well be thought of as an integrated functional unit and designed to minimize adverse social, economic, and health impacts across the entire range of food preparation activities, including protection of the cook and her family from smoke exposure. Although it may seem obvious that such ventilation ought to be included in new designs, there are many instances where it is not. Some designs promoted by the rural housing extension programmes of some of the major Asian countries, for example, do not explicitly include such features (Smith 1987).

Although changing the housing stock in any appreciable way is a truly long-term option, retrofit activities designed to improve ventilation would seem to be possible in short periods at low cost in many areas. It is essential to understand which changes would be most effective in individual situations. There may also be physical, social, and cultural barriers to such changes. Nevertheless, it would seem that such changes undertaken by motivated villagers could achieve markedly reduced exposures with essentially no outlay of money.

Role of women

Rural energy needs in DCs consist of fuel for heating and mechanical or muscular energy for producing and processing crops and for basic survival. Over the past decade, rural energy needs have been increasingly identified with fuel needs alone, leading to two solutions: planting more trees and introducing new designs for stoves that either are more efficient for traditional fuels or use different energy sources. On the whole, these solutions have not been widely successful for two reasons: the problem was not perceived accurately, and the solutions required more time and effort from rural women who already work long hours (Cecelski et al. 1979).

Only recently have those concerned with fuel shortage begun to consult rural women. The general failure of their technological solutions, which require great investments of women's time, reinforces the fundamental fact that the main barrier to rural development is the scarcity of women's time.

Many early development efforts have floundered on the same barrier. When the difficulty in reaching the rural poor was recognized during the late 1960s, the orientation of community development changed to an emphasis on basic human needs. With this new focus on people-oriented micro-level development came the realization that various programmes affect women and men differently. During the past decade, women's economic roles have been extensively documented in agriculture and in both rural (Dixon 1978) and urban (Jain 1980) enterprise. The data so produced indicates wide variations of women's work by region, culture, class, and ethnic group but several facts are consistent.

- Poor women everywhere work longer hours than men (Tinker 1987).
- The economic contributions of women, both monetary and nonmonetary are absolutely essential to the survival of poor families.
- Women's income generally goes entirely to household needs, whereas men's income does not.
- Water carrying and food processing are more sex-based than fuel collection.

The most critical fact is the inelasticity of poor women's time, particularly in rural areas. Any new activity required or requested as a result of development programming must be carefully weighed by each local woman against her current time allocations to ensure that a

change will not leave her and her family worse off. She will not use a lorena-type stove, if she has no time for gathering wood and not implement to cut the wood to size; nor will she add half an hour to her daily schedule to water newly planted trees if she cannot see a benefit to her or her family from this activity.

A better understanding of women's time will also aid in identifying primary constraints to rural development. Too often, solutions are preferred for problems which are not considered to be problems by the women who are supposed to benefit from the solutions.

Rural women are certainly not underemployed, but they are clearly under productive. Yet the technology that might make their tasks more productive is generally too expensive for the individual woman to buy; nor is it likely that the family will buy such technology for the woman. In most parts of the developing world, the dominant cultures assign very separate roles to the woman and the man. The household does not function as a cohesive economic unit. Yet new household economics assume that the household is a benign unit that maximizes benefits for all its members. This is simply not true. The distribution of responsibilities varies by society, and it is changing, particularly as activities are commercialized. Fuel is a good example, when it can be bought, the woman is freed from the drudgery of collecting it; however, the family budget is further strained.

The current focus on fuel issues at the rural level is laudable but insufficient. Much more emphasis needs to be placed on reducing the human energy demands by introducing appropriate mechanical substitutes. This must be done in a manner that does not further impoverish women who live in poor households or are themselves heads of households. If projects are undertaken without an understanding of the context within which rural energy programmes to aid the poor must operate, unexpected results may undermine the projects or actually make the life of the poor – especially poor women – more difficult. In fact, once the central energy problem of women's time is recognized, there may be other ways to address the rural time and fuel constraints, such as by increasing income, that will have an more immediate impact than imposing, for example, improved cooking stoves or new biogas digesters. The developing world is rapidly becoming urbanized. Neither the demands of women's time nor the problems inherent in energy needs for heat and for mechanical devices are limited to rural areas. Yet, there is very little understanding or appreciation of the problems of poor urban communities. This is clearly an area for further research and action.

Need for improved awareness

Though scientific and medical experts seem to realize that indoor air pollution is potentially a significant problem, the people who are really affected by it - the poor, especially women of DCs do not seem to be aware of the hazards they and their children face. Two surveys, one in Jakarta, Indonesia and another in Accra, Ghana highlighted the fact that households rank indoor air pollution as one of the least priority problems in comparison to other problems such as water, wastes, and pests (Surjadi et al. 1994, Benneh et al. 1993). Logically, even their willingness to pay for improvements in indoor air quality was found to be low. More significantly, this was found to be true across all income groups. Clearly, there is a need for better awareness and risk communication programmes.

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Water and sanitation

Introduction

The water and sanitation (W&S) sector has received considerable importance over the last decade-and-a-half. This is attributable to the International Drinking Water Supply and Sanitation Decade (IDWSSD) 1981–1990. An exhaustive amount of literature has been published on the subject. The documentation has focused on the accessibility status, community involvement, gender issues, water-borne diseases, etc.

Important international conferences have also yielded comprehensive documentation of the efforts in this sector. Some of the recent conferences are listed below.

- Asian and Pacific Consultation on Water Supply and Sanitation - Beyond the Decade, Manila, The Philippines, June 1990.
- International Conference on Water and the Environment, Dublin, Republic of Ireland, January 1992.

- United Nations Conference on Environment and Development, Rio de Janeiro, Brazil, June 1992.
- Ministerial Conference on Water Supply and Sanitation, Noordwijk, The Netherlands, May 1994.
- Fourth World Conference on Women, Beijing, China, September 1995.

The available literature on the W&S sector can be broadly categorized into the following segments.

- Status and review of achievements during the IDWSSD.
- Status and review of achievements of post-IDWSSD.
- Methodology and the necessity for community involvement.
- Case studies on community participation.
- Case studies on gender issues in water and sanitation.
- Case studies on water-borne diseases.

Literature on the status and review of achievements and community involvement

The accessibility of W&S facilities in both the developed and the developing world, and the need for community involvement has been highlighted over the years in the available literature. During the IDWSSD, exhaustive literature was published on the rationale and methodology for community participation, which is one of the main contributions of the decade. The literature emphasized the need for community involvement and the futility of undertaking interventions solely for handpumps and water taps.

In view of the increased awareness levels, several positive efforts were undertaken with the launch of the IDWSSD. Improvement in the access to facilities was a major step forward as most countries, especially in the developing world, allocated special funds for implementation of W&S programmes. There was substantial increase in aid flow from the developed world for implementing W&S programmes emphasizing community participation. The literature highlighted the need for community involvement in general, and women's involvement in particular. It also focused on the drudgery of women by estimating the time they spend in fetching water.

Documentation of the impact of water and sanitation facilities

The existing literature has focused mainly on issues related to the physical aspects, highlighting achievements primarily in terms of

access. A review of the literature indicates that it only partially documented the impact of W&S interventions. Most of the literature deals with water-borne diseases, particularly diarrhoea. Detailed epidemiology and related aspects have not figured prominently but have been referred to mostly in the form of case studies. One reason could be that W&S-related diseases are also associated with other aspects of the environment, and it is not always easy to differentiate the impact of W&S *per se*. On the contrary, there might be a possibility that increased access may have contributed to increasing insanitary conditions like improper disposal of the increased water volumes and led to an increase in water-borne and related diseases.

There is voluminous literature on the role and responsibilities of women in relation to W&S provision and use. Women who handle W&S at the domestic level are exposed longer, and hence are more vulnerable to water-borne diseases. However, little research has been done to establish the effects of inadequate W&S on women, in terms of household coping strategies, health impact of carrying water, or differential impact of water-borne diseases (WHO 1994). Moreover, considerable effort has gone into documenting technological innovations without determining the effect on health of women and children in operating inefficient technologies namely, lifting water from wells, operating heavy-handle handpumps, etc. Apart from dealing with the physical achievements of the programmes, it is vital to determine the gender-specific health impacts of the status of W&S facilities.

Access and equity

Background

Water and sanitation services are the basic necessities of a community, and the two most important preconditions for development, as they also play an important role in improving health and quality of life. To deny people basic W&S facilities is not just inhumane, but it also removes the first step from the country's ladder of development. Efficient W&S services are indicators of progress for a nation. Inadequate W&S coverage is one of the world's most serious environmental problems and may continue to do so in future.

Prior to the launch of IDWSSD, the W&S scenario in developing countries (DCs) was very poor, and the literature available was

limited. Accessibility to water was only 46% and sanitation facilities stood only 39% (WRI 1994). That was about all the focus the sector received.

As stated in Sontheimer's *Women and the Environment*, the United Nations General Assembly at its 1980 session proclaimed the period from 1981 to 1990 as IDWSSD, during which the member states were to assume a commitment to substantially improve the standards and levels of W&S services by the year 1990. The decade marked a new beginning in drawing the world's attention to the inadequacy of access to W&S facilities, and exhaustive literature was published, which highlighted the drudgery due to poor W&S conditions in villages. The IDWSSD was marked by a comprehensive documentation of the sustained efforts by the communities, governments, and international agencies to make adequate water supplies and hygienic toilets available to more people, particularly to the poor in DCs. The efforts of the countries and the agencies participating in the decade were enthusiastic, often innovative, and sometimes outstandingly successful.

The decade's most important achievements have been in the realm of ideas. Much more is known now than 10 years ago about handpumps and low-cost latrines. Invaluable knowledge has accumulated from 10 years of experience in implementing W&S programmes. This knowledge has changed our perceptions of the roles of not only of technology, but also of the primary users, the women. However, some of the more optimistic targets have not been achieved. At the end of the decade, even with more than US $100 billion investment, about 1.3 billion (32%) people still did not have access to safe drinking water, and nearly 2 billion (49%) did not have access to the simplest latrine (Table 1). Clearly, much needs to be done before safe W&S are available to all (Sontheimer 1991).

Various development reports published by the World Bank, the United Nations Development Programme (UNDP), and the World Health Organization (WHO) indicate that the progress in the DCs has been rather slow as the large investments required from governments are not forthcoming due to perennial resource constraints. Although DCs have seen a steady increase in the percentage of people with access to W&S facilities, the improvements in coverage continue to be overshadowed by rapid population growth. This means that ever-increasing populations have to be provided water supplies and sanitation simply to maintain the current rate of coverage. This is especially the case in urban areas, where natural growth is aggravated by rural–urban migration.

Table 1
Water supply and sanitation coverage (1980–90)

Facility	Portion of population with access to adequate facilities (per cent)	
	1980	1990
Overall water supply	46	68
Urban	75	85
Rural	34	59
Overall sanitation	39	51
Urban	60	74
Rural	31	40

Source. WRI 1994.

Without significant improvement in investment and coverage by 2025, over a billion people would still lack adequate water supply and more than double would have no sanitation facilities. This would be chiefly in the poorer countries of Africa and Asia.

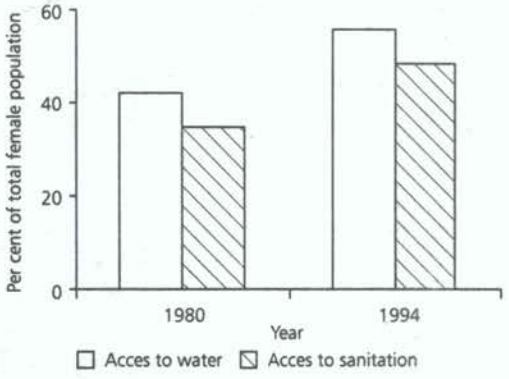
Women as primary users

Women, the primary users of W&S facilities, are most affected by the lack or inadequacy of the same. Women are responsible for collecting water, controlling its use, and also overseeing the sanitary arrangements. Water is needed for drinking, domestic purposes, personal hygiene and sanitation, farm use, and the many processes involved in food production and craftwork. Women have to bear the drudgery of ferrying water over long distances and also have to face the embarrassment of defecating in open areas (Cairncross 1992).

The gender desegregated figures for the world reveal that till 1994, women's access to safe water increased from 42% in 1980 to 56% in 1994, while their access to sanitation increased from 35% in 1980 to 48% in 1994 (Figure 1).

In the beginning, W&S projects focused exclusively on physical works. This thinking changed fast, fortunately, and at least a decade before IDWSSD was declared in early 1981, community participation was identified as the key to the success of W&S projects. But community participation had only men playing the lead role while women had no active presence. They became 'users' or 'target groups' for health education with only the community men being involved as leaders, committee members, and caretakers.

Figure 1
Women's access to safe water and sanitation globally



Note. Methodology for obtaining accessibility figures for women: the fraction of gender desegregated population for the seven main regions of the world as classified by WHO (Murray, Lopez 1996) has been multiplied with the water and sanitation access data as provided in The World Bank (1997).

Driving forces

Over the years, the main driving force for W&S programmes has been the existing gap between demand and supply, and ensuing health benefits. The effort to mitigate women's drudgery, and various socio-political compulsions have been other important factors for the implementation of W&S programmes in different countries. 'Water and Sanitation' published under the Discussion Paper Series of the UNDP–World Bank Water and Sanitation Programme elaborated on the various driving forces behind the W&S programme.

Gap between demand and supply

Most countries in Africa and many in Asia and Latin America are considered water-scarce countries. The proportion of rural women affected by water scarcity is estimated at 55% in Africa, 32% in Asia, and 45% in Latin America. Even in countries where there are adequate freshwater reserves, full coverage remains a difficult goal, for both water supply and sanitation. Hence, the existing gap between demand and supply is the main factor for pushing W&S programmes globally. 1994 figures reveal that, about 32% of the world's population still does not have access to safe water and 49% lacks proper sanitation facilities.

Health benefits

Improved health is the principal economic and social benefit that governments and other agencies seek to gain by investing in sanitation schemes, or by promoting such investments by individual households. The health effects of improved sanitation are well-known and the use of sanitary latrines bestows potential health benefits not only on the user household, but also on the neighbours, as their environment is protected from faecal pollution.

The World Bank (1993 a) has analysed the existing water supply problems. Adequate supply of safe drinking water is universally recognized as a basic human need. Yet over 1000 million people do not have ready access. Numerous physical, chemical, and biological agents render many water sources harmful for consumption. Even in countries where water is abundant overall, there are significant regions where seasonal water scarcity burdens women with time-consuming water collection. Health hazards in the aquatic environment and water-borne epidemics are mostly due to inadequate or even poor management of water resources, although adverse natural conditions are sometimes causative factors as well. Examples of the latter include areas where the natural geochemical composition of water supplies can lead to severe health impairments. Fluorosis in the Rift Valley and in Central Asia, and skin lesions due to arsenic intoxication, particularly in Asia and Central America are just two examples.

Today's perception of water problems in the world is based largely on the idea of a North–South dichotomy. This holds that developed countries are rich and highly industrialized and, as far as water is concerned, mostly preoccupied with chemical pollution. Conversely, DCs are held to be mostly poor and agriculturally-oriented, and suffer water pollution problems caused by contamination of watercourses by bacteria, parasites, and a host of microbial disease vectors. These, however, are oversimplifications. Developed countries are by no means protected from communicable diseases. General mobility and tourist influx render their populations vulnerable to all sorts of biologically-transmitted diseases, including water-borne (and food-borne) gastro-intestinal disorders. Many small community water supplies and family wells are not of an acceptable microbiological quality (The World Bank 1993 a).

Meanwhile, the concern of many DCs about water quality goes far beyond microbes. Chemical pollution of water sources, for instance, is increasing with industrialization and the widespread use of agricultural chemicals. This double-edged problem is most pronounced in countries in the process of industrialization and in

economic transition. In these countries, the traditional problems of domestic sewage collection, treatment, and disposal have not yet been resolved because creation and maintenance of sanitation infrastructure have not kept pace with industrial and urban development. Investments in drinking water supply, treatment works, and distribution networks have not matched population growth and socio-economic development, and industrial expansion has resulted in inadequate treatment or uncontrolled discharge of waste water. Consumers are thus not sufficiently protected from microbial and chemical contamination. Also it is likely that the potential health benefits will not be fully realized by a sanitation programme unless it achieves a high degree of coverage and usage. If 90% of a given community owns latrines, the transmission of excreta-related diseases may still be maintained by the promiscuous defecation of the 10% which does not, or even by those members of latrine-owning families who do not always use the latrines they own (The World Bank 1993 a).

Women's drudgery

Health benefits are not the only motives for promoting W&S facilities in low-income communities. Workers often mention that a more effective selling point for potential users is the convenience and privacy a facility can offer. For example, a survey of rural households in the Philippines elicited the following reasons for satisfaction with a new latrine (note the order).

1. Lack of smell and flies
2. Cleaner surroundings
3. Privacy
4 Less embarrassment when friends visit
5. Less gastro-intestinal disease

Privacy, avoidance of embarrassment, and convenience are certainly important factors for women to opt for a toilet programme. It is not only a matter of embarrassment and convenience as hazards of defecating in the open are much higher for women than men. Clearly, if poor families are willing to pay for privacy and convenience, as they often are, these are benefits to which monetary value can be applied.

Women as water collectors and carriers

Lack of time and energy among women affects the selection of water sources and can limit the availability of safe water at home. Collecting water can be an arduous task especially as it needs to be undertaken several times a day (Table 2). The nearest source may entail walking

several kilometres in the dry season; paths to springs and other sources may be steep and treacherous; or women may need to wade thigh deep in mud to reach clear water. Some women carry water in containers balanced on their heads or in cans strapped to their backs, which may weigh up to 20 kg or more. To quote an example of the Kikuyu women in Kenya,

> *Almost as soon as they can walk, small girls go with their mothers and elder sisters to the well or river. The tin they carry grows bigger as they get older, starting out no larger than a fruit juice can and ending with the four-gallon earthenware jars or brass pots of their mothers. Carrying water is so integral to their lives that it is scarcely something to grumble about. Yet in some parts of Africa, women spend eight hours a day collecting water. The journey is exhausting, eating into the time and energy they have for other things. And the continual water bearing can distort the pelvis of young girls, making the recurrent cycles of pregnancy and childbirth more dangerous* (Rodda 1994).

Table 2
Time spent by women in drawing and carrying water, 1975–82

Region	Hours per week
Sub Saharan Africa	4.65
India	2.73
Other Asian Islands	5.23
Latin America (Ecuador)	0.96

Source. WHO 1987 a.

In areas where water has to be pumped, pumps were laid without taking women into account either in the design or in location (Box 1). The handle is often difficult to reach, and heavy to use, and when the pumps break down, women are not trained to repair them. The quality of water is often poor, for example water in a village in the Sahel being described as, 'the filthiest I have ever seen, the colour of clay, with wriggling insects and larvae visibly swimming around in vast numbers' (Rodda 1994). In urban areas, shanty towns frequently lack public water points, and women either have to go to sources some distance away, or buy water from vendors who deliver it by bucket,

donkey cart, or in main streets by large tankers. Water vendors charge a high price, which is difficult for poor households to afford. The lack of sanitation and overcrowded conditions in these areas cause severe health hazards. Obtaining water is especially difficult in times of drought. For example, in Chennai, India, during 1983, water was supplied on alternate days, and women and girls had to walk two kilometres at night to collect it. In the more prosperous suburbs, women were hired to travel to the city by train to get water, while in the slums women had to extract water from holes in the beach. Very few men carried water, although some did escort women to the taps at night. Some men carried water on bicycles and carts as a commercial enterprise.

Hence, privacy and reduction of drudgery are two important driving forces for provision of proper W&S facilities. Actually, privacy and convenience, in the context of human defecation and the drudgery of ferrying water, are really synonyms for human dignity. If the quality of life is degraded for all when some of a community's members have no toilet and potable water facilities, then the quality of life for all is that much the better when they have one (Rodda 1994).

Social factors

Dignity of the users is not the only issue. Some antiquated sanitation systems require people to indulge in degrading work like removal of wastes for disposal. This was the case with the bucket (in practice, more often a basket) latrines of India, traditionally emptied by sweepers drawn mainly from the scheduled castes. For centuries, the unsavoury nature of the work perpetuated their low status in society. The desire to emancipate these persons from their 'untouchable' status is the primary factor in the Indian government's commitment to eliminate bucket latrines and promote more hygienic sanitation systems.

Political factors

There are sound political reasons for promoting W&S. It is particularly popular in urban areas, and the promise of it can win political support. If appropriate technology is employed, it can be a vote-catching measure. Water and sanitation often feature on the agendas of community organizations and of local politicians in urban slums and shanty towns, notably in Brazil.

The political potential of W&S is not measured only by the expressed demand. Demand stimulated by a W&S programme is real, as seen in Zimbabwe. Before independence, the demand for pit

Box 1
A day in the life of Aling Maring

A village woman in The Philippines, Aling Maring gets up quickly as she sees the sun slowly beginning to rise. It is only 4 a.m. but she knows she has many tasks to do before the others in her household wake up.

Aling Maring goes back to the kitchen with a sigh, to get the pail before going out to the door to start the long one-kilometre trek to the village pump. Luckily, she is only tenth in queue when she gets there. There are sometimes over 50 women in queue.

The village pump is always a meeting place for women while waiting in queue to collect water. It always takes so long for one to finish collecting enough water. The wooden handle is so long and heavy that it takes all her strength to push it down with enough speed to pump any water out. Also the handle is large and rather high for the average height of women, making it even more cumbersome to grasp properly. By the time Aling Maring gets home, her family is awake and hungry. She calls her eldest son to go and gather some firewood which would save her an extra chore. In the meantime, she lights the wood left over from yesterday's fire and sets some water to boil.

After a quick breakfast, the two elder children prepare for school. They go off to the outhouse where there is a pail of water for bathing. They use this to clean themselves as best they can. They defecate in a latrine nearby. Because there is not enough water, they do not bother flushing the toilet. Meanwhile, Aling Maring goes outside to look in her small drum of water for washing. This too is almost empty. She must get this filled up, if she is going to get any chores done. So she asks her daughter to keep an eye on the two younger ones and takes the baby with her, to fetch more water.

This time, the queue is longer and she must wait longer too. After washing the breakfast dishes and quickly cleaning up the house, it is time to wash clothes. Aling Maring does this together with bathing the children. She gathers up the laundry and tells the children to follow her down to the laundry where there is a shallow pool. Already there are some women washing, but she can probably squeeze in at the corner. The children jump into the pool while Aling Maring begins to wash with the tiny bit of soap left over from yesterday's washing.

Thus goes the story of Aling Maring, typical of women in rural and urban areas, whose domestic functions put them in constant touch with water.

Source. Marion Maceda-Villanueva 1984.

latrines in rural areas was small, but the success of the rural sanitation programme has made a VIP latrine, the aspiration of most rural Zimbabweans. The widespread introduction of these latrines is one of the most visible and popular achievements of the post-independence government.

Future perspective

The future perspective is reflected in a final, fundamental reason for promoting W&S. Its strength is hard to evaluate precisely, but is worth consideration. As low-income communities grow and consolidate, their population density tends to increase and their housing becomes more substantial. If W&S facilities are not provided early in the process, their installation becomes increasingly difficult and expensive both to the individual and to the community, especially if housing has to be demolished to make way for pipes and public toilets. The poor cannot afford to plan for the future, but governments and city authorities cannot afford not to do so. Today's peri-urban areas may become tomorrow's central cities. Water and sanitation facilities are a basic part of the infrastructure of any civilized community, and installation is cheaper the earlier it is carried out. Long-term savings made possible by timely installation of durable, upgradable systems can logically be considered an external benefit justifying government subsidy (Cairncross 1992).

Water and sanitation access and equity

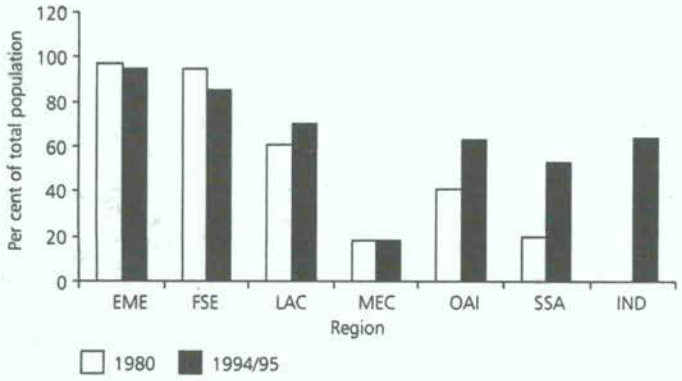
Safe W&S facilities for all populations can only be guaranteed when access, equity, and sustainability are assured. Access describes easy availability of safe drinking water and sanitation facilities for meeting basic personal health and hygiene needs. Equity refers to equitable distribution of water supply sources and sanitation facilities between countries, between rich and poor populations, and between rural and urban areas within countries. Sustainability is a newer concept and reflects uninterrupted availability of the facility in future for maintaining initial qualities and standards.

Access to safe water

As per the recent statistics available from WHO (1996 b), the number of people without access to safe water (i.e., unserved) dropped from 1600 million in 1990 to 1100 million in 1994. Currently, more than 800 million of the unserved live in rural areas. At the same time, the number of urban unserved is actually rising sharply in the DCs due to rapid urbanization, much of which is occurring in peri-urban and slum areas.

The gender desegregated figures for the seven main WHO regions of the world reveal that as per the figures for 1994, of the total female population, women's access to safe water increased in the developing world while for the developed world it showed a slight decline (Figure 2).

Figure 2
Women's access to safe water in selected regions 1980–94



Source. Adapted from *Global Burden of Diseases* (1996) and *World Development Indicators* (1993).

Methodology for obtaining accessibility figures for women: the per cent of gender desegregated population for the seven main regions of the world (WHO classification) as provided in the *Global Burden of Diseases* has been multiplied with the W&S access data as provided in the *World Development Indicators*.

Note. EME–Established Market Economies; FSE–Formerly Socialist Economies; LAC–Latin America and Caribbean; MEC–Middle Eastern Crescent; OAI–Other Asian Islands; SSA–Sub-Saharan Africa; IND–India (1980 figure not available)

Although the per capita water availability is continuously being reduced due to increasing population density, and water being scarce in many regions, urban water utilities have been able to achieve at least partial coverage. The future outlook is rather bleak, and a water crisis is predicted for many developing and underdeveloped countries in the first half of the next century (Table 3). Large-scale agricultural and industrial use will make it more difficult, and certainly much costlier to supply urban areas with drinking water in an increasingly competitive water market.

Access to sanitation

During the course of IWSSD, access to adequate sanitation increased from 60% to 74% for urban population, and from 31% to 40% for the rural population.

A survey of 99 DCs (Table 4) indicates that in only 28% countries peoples access to sanitation was in the range of 75%–100%. In 37 countries more than half the population did not have access to proper sanitation facilities.

Table 3
25 countries, where half or more of the total population had no safe drinking water supply in 1994

Country	Percentage without safe drinking water		
	urban	rural	total
Afghanistan	61	95	88
Central African Republic	82	82	82
Chad	52	83	76
Zaire	63	77	73
Papua New Guinea	16	83	72
Haiti	63	77	72
Madagascar	17	90	71
Liberia	42	92	70
Angola	31	85	68
Mozambique	83	60	68
Sierra Leon	42	79	66
Uganda	53	68	66
Vietnam	47	68	64
Mali	64	62	63
Myanmar	64	61	62
Lao PDR	60	61	61
Nigeria	37	74	61
Swaziland	59	56	57
Iraq	—	—	56
Nepal	34	59	56
Zambia	36	73	57
Malawi	48	56	55
Sri Lanka	57	53	54
Benin	59	47	50
Sudan	34	55	50

Source. WHO 1996 a.

The gender desegregated figures for the seven main regions of the world reveal as per the figures for 1994, out of the total female population, women's access to sanitation has increased in both the developing and the developed world (Figure 3).

A study covering selected DCs revealed that primary schools in some of the poorest countries have inadequate sanitation facilities. The worst situations exist in rural schools of Bangladesh, Maldives, and Nepal, where, on an average, more than 90 students share one

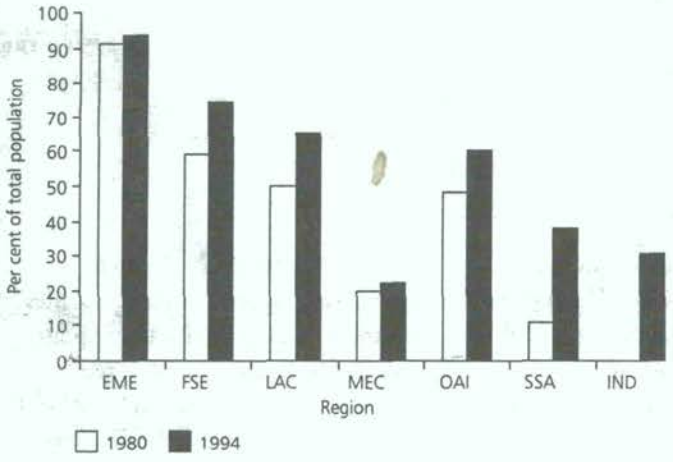
Table 4
Access to sanitation in the developing world

Region	Countries surveyed	Level 1	Level 2	Level 3	Level 4
Sub-Saharan Africa	38	3	14	11	10
Middle East and North Africa	16	8	8	—	—
Central Asia	4	3	—	—	1
East/ South Asia	20	6	4	5	5
India	21	8	8	4	1
Total	99	28	34	20	17

Source. WHO 1996 b.

Note. Level 1: 75%–100% access; Level 2: 50%–74% access; Level 3: 25%–49% access; Level 4: 0%–24% access. The definition of access varies by country and refers to a means of sanitation either in the dwelling or at a convenient distance. (Note that comparable sanitation data does not exist for Europe).

Figure 3
Women's access to sanitation for selected regions 1980–94



Source. Adapted from *Global Burden of Diseases* (1996) and *World Development Indicators* (1993).

Methodology for obtaining accessibility figures for women: the per cent of gender desegregated population for the seven main regions of the world (WHO classification) as provided in the *Global Burden of Diseases* has been multiplied with the water and sanitation access data as provided in the *World Development Indicators*.

toilet. In comparison, rural schools in Burkina Faso, Madagascar, and Togo have fewer than 50 students per toilet. In urban areas, these three countries (Burkina Faso, Madagascar, Togo) are among those with the worst record, with more than 50 students per toilet on an average. Six countries have fewer than 50 students per toilet in city schools. None of the 14 countries have increased the number of school toilets by more than eight per cent since 1990, suggesting that they are barely improving facilities, let alone keeping up with the rise in student population.

The record on toilet conditions is equally dismal (Table 5). In Bangladesh, Maldives, and Nepal, around half the school toilets cannot be used, as they are either unclean (flush toilets) or in need of a new place (latrines). Cape Verde rates best in cleanliness, with 91% of toilets being cleaned daily. In Bangladesh, 40% of the schools reported that toilets are not cleaned even once a week.

Table 5
Status of latrines in developing countries

Region	Pupils per toilet		% toilets non-usable
	rural	urban	
Sub-Saharan Africa	392	299	39.2
Other Asian Islands	408	210	25.2
Latin America (Ecuador)	392	299	39.2

Source. Schleicher, Siniscalco, Postlethwaite, 1995

The scenario concerning provision of safe water in schools is better and in Cape Verde, all schools have safe water. Bhutan provides water to 95% of schools and Maldives to 90% of schools. Inadequate W&S in schools not only jeopardize students' health but also reduce their attendance. Girls in particular, are likely to be kept out of school in absence of sanitation facilities (Schleicher, Siniscalco, Postlethwaite 1995).

Factors affecting progress in sanitation

Growth in sanitation coverage has been much slower than that in water supply. A report has highlighted the factors responsible for inadequate progress in the sanitation sector. The main factor has been

lack of resources. Even low-cost, on-site sanitation is more expensive than its water supply equivalent, the handpump or public stand-post. The WHO in 1987 reported a median capital cost per capita of US $120 for on-site urban sanitation in the least-developed countries, and only 60% of this amount for stand-post water supply.

It is a fact that individuals, communities, governments, and agencies have spent less on sanitation than on water supply, since it is usually a lump-sum investment, whereas the capital cost of water supply is usually recovered from consumers in the form of tariffs over many years. For governments too, investment in water supplies is usually more attractive. Despite all the persuasive arguments for sanitation outlined above, popular demand for water supply is usually stronger, and most politicians would prefer, other things being equal, to have their names linked with water taps than with toilets.

Implementation constraints

Lack of resources is not the only reason for slow progress in sanitation coverage. Low-cost sanitation programmes are far more difficult to implement than water supply schemes, for several reasons. The first has to do with the technology. Water supply systems are built in only a limited number of ways and with a limited range of materials, and in general, the solutions in appropriate textbooks and manuals will suffice. Low-cost sanitation systems, on the other hand, usually require adaptation to local cultural preferences, locally available building materials, and local ground conditions. The systems most likely to succeed are usually those which build on local customs and techniques rather than replacing them with imported solutions. An engineer must exercise a far greater degree of creativity and flexibility while constructing low-cost sanitation systems.

This difficulty has been mitigated to some extent by the work of the World Bank, with support from UNDP. The Bank's Technology Advisory Group (TAG) devoted several years on the study of successful indigenous technologies and produced manuals on sanitation technology and its selection. More recently, TAG established the International Training Network for Water and Waste Management, which has helped to make the training of engineers and technicians in a number of countries more appropriate to local needs.

User commitment

Many of the difficulties in implementing sanitation programmes arise from the fact that sanitation improvements are interventions in the domestic domain. A latrine is part of its owner's house, largely built at

the owner's expense, and frequently with the owner's labour. Its use requires a change in people's most private habits. In most poor communities, by contrast, the water supply is very often located in a public place, either in the centre of the village or a tap located on the corner of the street. This difference generally means that greater commitment by the user is needed for installing a latrine than for water supply. Most of the initial investment in sanitation must usually come from the user, whereas investments in water supply can more easily be recouped subsequently through the water tariff. The latrine user will often be expected to acquire most of the materials required for its construction, although this is not required in even the most participatory 'self-help' water supply schemes.

Commitment by the householder is required not only to build a latrine, but also to ensure its proper use by all the family members. In all probability, the mother is the only collector of water in the household, so she need not influence the behaviour of anyone else to change the source of drinking water. But to change the defecation habits of everyone in the family is far harder to achieve, however willing she herself may be. Moreover, user commitment to sanitation is less likely to be present than that to water supply. The convenience and aesthetic advantages of a ready source of clean water is usually apparent to all, any DC politician knows how popular water supplies can be. Not everyone is convinced, however, of the advantages of latrines. For those accustomed to a contemplative squat in the cool, open air of an early morning, who among them would choose a dark, damp, smelly, and possibly precarious cubicle (Cairncross 1992).

High level of awareness

Considerable persuasion is required in most successful sanitation programmes, call it health education or salesmanship. People need to be convinced of the advantages of owning a toilet. Interpersonal contact, rather than mass media, is required for communication to be effective. Individual households and communities also need guidance on how to build and use their latrines, and encounter related problems that cannot always be foreseen. Thus, the promotion of sanitation requires a cadre of well-trained people in the field. They should have the same cultural roots as those they serve, and must understand the technical aspects of low-cost sanitation. Above all, they must be sensitive.

Conclusion

Although the number of people without safe W&S facilities dropped during 1990–94, the number in Africa, Latin America, and the Caribbean has actually increased. Almost all of the coverage gains have been in Asia and the Pacific (WHO 1996 a). Wide variation occurs within countries too. For instance, urban areas generally have a higher coverage than rural areas. Even within areas, inequitable distribution can be very marked. In cities, water is often supplied to populations who can pay for services, the wealthier areas often benefit from subsidized tariffs, with the result that water is used for non-essential purposes such as washing cars, watering lawns, and filling swimming pools.

Meanwhile, in poorer areas, thousands of people may not have access to a toilet, and for water they may be dependent on standpipes which are poorly and/or intermittently supplied and for which people have to queue for long periods. Or even worse, they may have to buy water of doubtful quality from private vendors at prices that may be 10 to 20 times higher than the average inner city water tariffs. The health consequences resulting from the deprivation caused by this inequity are sometimes considerable, as evident from the infant mortality rates of the rich and the poor – which may vary between two and ten times in magnitude – and the large number of urban poor who are at high risk from epidemic diarrhoeal diseases such as cholera.

Health effects

Introduction

Water supply, sanitation, and waste disposal all contribute strongly to overall health. Adequate water supply, water quality, and sanitation are important for the health and welfare of the society. Supply of adequate quantity of water is a prerequisite for facilitating domestic activities and better hygiene practices. Water quality is linked to the health status of consumers, and it is estimated that as many as 80% of diseases in the world are associated with water usage or poor environmental hygiene. Recent statistics based on the estimates of IDWSSD indicate that over 1.2 billion people suffer from poor water supply and over 1.7 billion people are affected due to lack of sanitation and waste disposal (Silverberg 1994). Water causes various

diseases in many ways. It would be by drinking contaminated water, or through contact with an aquatic invertebrate living in contaminated water, or even the lack of availability of W&S. The infection can also spread through mosquitoes or insects that depend on water. Based on the mode of transmission, diseases can be classified into four main categories.

- Diseases due to water contamination (by agents microbial or chemical) – water-borne diseases.
- Diseases due to lack of water for personal hygiene – water-washed diseases.
- Diseases transmitted through aquatic invertebrates – water-based diseases.
- Diseases spread by insects that depend on water – water-related vector-borne diseases.

Water-borne diseases

Water-borne microbial diseases

Organic material from domestic sewage, municipal waste, and agro-industrial effluents is the most common water pollutant. This organic waste comprises faecal material, some of which may be infected by pathogens such as viruses, bacteria, and other biological organisms causing water-borne infections. These pathogens are present in sewage that is discharged directly into water courses. Pathogens can also enter water supplies from storm runoff, or as a result of soil percolation from landfills, or from agricultural areas where primarily treated waste water is used on crops. Some of the water-borne microbial diseases are diarrhoea, cholera, and typhoid. Even though these diseases affect all age groups, the impact is higher among children due to low level of immunity.

Water-borne chemical diseases

These diseases are caused by toxins suspended or dissolved in water. Some of these toxins may be of natural origin, like fluoride dissolved in groundwater from soil. Several other toxic substances originate from various forms of pollution such as agricultural chemicals (fertilizers, pesticides), industrial wastes, etc. If the toxic chemicals are in high concentration, diseases may be manifested in acute form. However, usually toxic substances are in such low concentrations that they only have a cumulative effect leading to chronic disease.

Water-washed diseases

Diseases due to lack of water for personal hygiene tend to be serious health hazards. When people use very little water, either because there is low availability or the source is too far away for water to be carried home in sufficient quantities, it is extremely difficult to maintain a reasonable level of personal, household, and environmental hygiene. Water-washed diseases include most of the faecal–oral transmission diseases, which may be affected by washing. Other water-washed diseases are skin and eye infections.

Water-based diseases

All worm infections are classified under water contact diseases. Several are due to flukes and trematodes whose larvae depend on aquatic snails. The eggs pass from excreta to water and the larvae emerging from the snails may be ingested with domestic water directly or on food plants or animals which acquire the encysted larvae from the water. Some worms enter the human body through the skin.

Water-related insect vector-borne diseases

The aquatic environment provides an essential habitat for mosquitoes and other vectors which act as hosts for parasites that cause human diseases. Malaria, yellow fever, and filariasis are some of the water-related insect vector-borne diseases.

The classification of water- and sanitation-related diseases and the main diseases in each category are given in Table 6.

In addition to exposure, other factors also influence the incidence of disease and its impact. These are discussed under risk factors below.

Risk factors for water-borne microbial diseases

Diarrhoeal diseases, the main water-borne microbial diseases, are greatly influenced by the level of economic development.

Underdevelopment

Underdeveloped and developing countries lack access to safe drinking water and basic sanitation in the household and in the community. In underdeveloped countries, more than 70% of the population suffers from infectious diseases. These diseases are transmitted through poor water quality, sanitation, and housing (Zaidi 1988). According to

Table 6
Classification of diseases in relation to water and sanitation

Category	Examples	Relevant water improvements
1 Water-borne infections	diarrhoea	
microbial	typhoid, cholera	microbiological sterility
chemical	fluorosis	drinking water treatment
2 Water-washed infections		
skin and eyes	scabies, trachoma	greater volume availability
diarrhoeal diseases	bacillary dysentery	greater volume availability
3 Water-based infections		
penetrating skin	schistosomiasis	protection of user
ingested	guinea worm	protection of source
4 Insect vectors related diseases		
vector bite	sleeping sickness	piped water from source
breeding in water	yellow fever	piped water to site of use

WHO, the total coliform count in drinking water should not exceed 10 per 100 ml, and faecal coliform concentrations should be zero per 100 ml. In the underdeveloped and DCs, adequate treatment and disinfection of drinking water is limited.

It has been reported that the faecal coliform count in the stretch of Yamuna river before it enters New Delhi, India is about 7500 per 100 ml whereas the faecal coliform in the stretch which leaves the city is about 24 million per 100 ml. The drastic increase is due to the dumping of 200 million litres of raw sewage into the river daily.

The diarrhoeal episodes are five to six times more common in DCs than the developed countries. This also reveals the link between economic development and water-borne diseases.

Age

The level of immunity is very low among infants and children, making them highly prone to diarrhoeal diseases. Thirty per cent of the estimated deaths due to various causes occur before 15 years of age. For diarrhoeal diseases, 88% of the total deaths occur in the age group of 0–14 (Murray, Lopez 1996). It was also estimated that a child born in 1992 in sub-Saharan Africa has a 25% risk of dying before 15 years of age, whereas in established market economies the risk is 2%. In Latin America, Carribean countries, and the former socialist

economies of Europe, the risk is intermediate in position. This inequity is due to the level of development (WHO 1997). Literacy levels of the mother or the care provider also influence the incidence of diarrhoea among children. A study conducted in the rural zones of Ivory Coast showed that the relative risk of diarrhoea among children whose care provider is illiterate is 1.22. (Messou et al. 1995).

Migration

Population movement or migration occurs due to various reasons – war, environmental disaster, or drought. People who are forced to leave their traditional habitat also face several risks. Refugees often do not have access to adequate W&S facilities and are particularly vulnerable to water-borne diseases. For example, in 1994, the town of Gama in Zaire was strewn with corpses of Rwandan refugees who had suffered such conditions (Box 2).

Box 2

Public health impact of Rwandan refugee crisis: what happened in Goma, Zaire, in July 1994? Goma Epidemiology Group

The flight of 0.5–8 million Rwandan refugees into the North Kivu region of Zaire in July 1994, overwhelmed the world's response capacity. During the first month after the influx, almost 50 000 refugees died, an average crude mortality of 20–35 per 10 000 per day. This death rate was associated with explosive epidemics of diarrhoeal disease caused by *Vibrio* cholera 01 and *Shigella* dysenteriae type 1. Three to four weeks after the influx of refugees, acute malnutrition rates among children under five ranged between 18% to 23%. Children with recent history of dysentery and households headed by women were at high risk of malnutrition. A well-coordinated relief programme, based on rapidly acquired health data and effective interventions, was associated with a steep decline in death rates to 5 to 8 per 10 000 per day by the second month of the crisis. The prevention of high mortality was due to disinfected water, basic sanitation, community outreach, and effective case management of ill patients. In the emergency phase, effective, low-technology measures include bucket chlorination of untreated water sources, designated defecation areas, active case-finding through community outreach, and oral rehydration. Relief agencies must place increased emphasis on training personnel in relevant skills to address major public health emergencies caused by population displacement.

Source. Lancet 1995.

Toole and Waldman (1990) reported that the expected mortality rate was about 60 times higher among refugees and displaced populations. The population migration in northern Ethiopia in 1985 and southern Sudan in 1988 suffered the highest crude mortality rates. This shows the vulnerability of migrant population.

Pregnancy

Pregnancy and malaria

Studies reveal that pregnant women are at greater risk of malaria infection than those not pregnant, and also in setting of both low and high transmission of malaria. Diagne et al. (1997) reported that the incidence of malarial attack was, on an average 4.2 times higher during pregnancy. Studies reveal that malaria in pregnant women may lead to anaemia which in turn affects the birth weight (Box 3).

Box 3

Seasonality, malaria, and impact of prophylaxis in a west African village I: effect of anaemia in pregnancy

> The importance of malaria as a cause of anaemia during pregnancy in endemic areas remains controversial. The prevalence of anaemia in pregnant women following the dry (May) and rainy (November) seasons was compared in two successive years in Bougoula village (region of Sikasso, Mali). Phase I in 1992 was observational and included 172 pregnant women and 208 controls. Phase II in 1993 included 174 pregnant women and 204 controls, where malaria prophylaxis with progunail (200 mg/day) and chloroquine (300 mg/week) was administered to pregnant women. A strong seasonal variation in the prevalence of moderate to severe anaemia in pregnant women (hematocyte%) occurred in phase I. This variation was present only in women of parity lower than five, and parallel variation in parasitemia. In phase II, the seasonal variation of anaemia was suppressed in women under malaria prophylaxis (presence of antimalarial metabolites in urine), and the overall prevalence of moderate to severe anaemia in pregnancy decreased by 55.5% (22.8%–74.3%). We conclude that malaria is the major cause of anaemia in pregnancy in this region. High priority should be given to the prevention of malaria during pregnancy.
>
> Source. Bouvier P et al. 1997.

Pregnancy and hepatitis

Data gathered by WHO indicates that the Hepatitis E virus (HEV) is widespread in several countries of south-east Asia and may account for

up to 90% of all sporadic cases of acute viral hepatitis. In 1955, in the Delhi (India) outbreak, the first of its kind to be documented, men and women were affected almost equally, but young adults were the most affected. In general, the disease ran a benign self-limited course. Pregnant women were an exception to this rule, with a case-fatality rate of 10% from hepatitic failure. Women in the third trimester of pregnancy were especially at risk.

Until 1980, the Delhi outbreak was believed to be due to infection with Hepatitis A virus (HAV). However, investigations following another outbreak in 1976, in Ahmedabad, Gujarat revealed that both the epidemics were due to HEV. Meanwhile, an outbreak in Kashmir was clearly associated with faecal pollution of a local stream, which was the main source of drinking water for the affected population. The severe illness that this infection produces in pregnant women was also apparent in this epidemic. Frequency of hepatitis was greater in pregnant women (17.3%) than in either non-pregnant women (2.1%) or men (2.8%). The frequency of disease in the first, second, and third trimesters was 8.8%, 19.4%, and 18.6%, respectively. Liver failure developed significantly more often in pregnant women (22.2%) than in men (2.8%). It did not occur in non-pregnant women. Similar findings were reported by Kharouf et al. (1980) in their case study on hepatitis and pregnancy in Tunis (Box 4). A study conducted in China also reveals that the rate of attack of hepatitis E is high in pregnant women. In their case, the fatality rate was about 6% and the abortion rate was 17.6% (Xia 1991).

Pregnancy and cholera

In case of cholera also the risk is high among pregnant women. A case study conducted in Mexico indicates the complication and treatment of cholera during pregnancy (Box 5).

Chemicals in drinking water: risk factor

A variety of acute and chronic health effects have been reported as a result of human exposure to chemicals. Actual risks are determined by the chemical concentration in drinking water. Thus many toxic substances, if present below a certain threshold level, do not pose a health hazard. Table 7 lists the threshold level for some of the chemicals and the health impacts.

Box 4

Hepatitis and pregnancy in Tunis: 103 cases compared with 100 cases who were not pregnant

The notes of 103 pregnant women who contracted hepatitis during pregnancy were reviewed and compared with a controlled series of hepatitis occurring in 100 women who were not pregnant but were of reproductive age. The mortality rate in the pregnant group was considerably higher than those who were not pregnant. 27 deaths out of 103 cases as against 4 deaths in the control series of 100 cases was observed. The foetal prognosis was very bad in the group of women who died. Three out of four pregnancies resulted in the loss of foetus. It was not so bad in those who had mild hepatitis. 39.3% lost the foetus and one out of two had premature labour. Loss of consciousness was a very bad prognostic sign. The prognostic value of marked drop in prothrombin and rise in white blood cell counts was noted in the cases of who died. When the series of women who were pregnant and survived were compared with those who survived in the control group, it was found that judgement had to be used carefully in evaluating the prodromal signs in the pregnant women. They found in the two groups that the haemoglobin level and the serial levels of protein and albumen are comparable to those found in developed countries.

Source. Kharouf et al. 1980.

Box 5

Complications and treatment of cholera during pregnancy

Since 1961 cholera has spread in many countries reaching a pandemic form. Mexico has been involved in this pandemic since 1991. Nearly 20% of cholera cases in Mexico are seen in fertile women, so the possibility of the association between cholera and pregnancy is high. We present the case of a pregnant woman, who during her third trimester got infected with an episode of cholera, developing premature labour.

Source. Damian et al. 1994.

Fluoride in low concentrations helps to prevent dental caries. But in high concentrations, it affects the teeth and bones and causes dental and skeletal fluorosis. The risk of dental fluorosis is high among children while that of skeletal fluorosis is high among people who drink groundwater in the fluorotic area.

Table 7
Threshold Limit Value for some chemicals and related health impact when the level exceeds

Chemical	Threshold Limit Value (mg/l)	Health impact (when the level is exceeded)	Remark
Fluoride	1.00	Fluorosis	
Arsenic	0.05	Peripheral vascular disease ('black foot disease') and skin disease	
Lead	0.10	Accumulates in the body and affects the central nervous system	Children and pregnant women are most at risk
Nitrate	45.00	'Cyanosis' or blue baby syndrome among children	Children are at risk
Cadmium	0.01	Bone disease–'Itai-Itai'	Mainly affects women

Source. compiled from National Academy Press 1980.

Cadmium

The health impact of cadmium is more severe in women than men. In water-polluted areas of Japan, a severe bone disease called 'Itai-Itai disease' was known to have been caused by cadmium pollution from a lead–zinc mine. The bone disease affected women only, although the whole community had been exposed (Box 6). The likely reasons were the poor diet of the women and interference of cadmium with calcium metabolism essential for bones. Similar exposure conditions in rice-producing DCs merit vigilance against this problem. In addition, a potential link between cadmium exposure and osteoporosis could further implicate cadmium as a major threat to women's health.

Nitrates

The use of fertilizers and organic manure increases nitrate concentration in the soil, water, and other products. Western Europe and the United States used nitrogen fertilizers extensively to increase agricultural production. This increases the nitrate level in soil and water and European rivers have the highest nutrient levels. In some cases, nitrate levels are 45 times the natural background concentration. High nitrate levels leads to cyanosis among children and bottle-fed

Box 6
Mainly women affected by cadmium

The epidemiological studies revealed that all the patients were women, mainly above 40 years of age and with a history of many pregnancies. By 1989, a total of 150 women had been officially identified as cases of Itai-Itai disease; 100 of them had died. Intensive epidemiological studies in the cadmium-polluted areas of Japan identified a small number of suspected cases with similar symptoms. The initial less severe stages of cadmium poisoning include damage to the kidneys. This was found in thousands of people in several polluted areas, and often to the same degree in men and women.

There are several likely reasons for women being particularly susceptible to this type of poisoning from water pollution. Firstly, the bone effects are related to calcium metabolism, which tends to get depleted in women by frequent pregnancies and is further exacerbated after menopause. Secondly, women in the affected area are reported to have had a diet lower in protein and minerals which in itself could have reduced the strength of their bones. Thirdly, the women who fell ill, were generally kept inside the house without treatment until the condition became severe. Lack of sunlight during the early stages of illness may have contributed to the development of severe bone disease, as sunlight exposure to the skin produced vitamin D which could have counteracted the impact of cadmium damage.

Cadmium polluted areas have recently been found in rice-producing DCs where the conditions for women may be similar to those in Japan in the 1950s. Similar outbreaks of cadmium-induced bone disease in women may occur elsewhere, unless areas around mines, smelters, and factories producing or using zinc, lead, copper, or cadmium are properly assessed for pollution and human exposures, and appropriate control measures are taken.

Source. WHO 1992.

babies are at high risk. Now the fertilizer use in DCs is also increasing. High nitrate level may also lead to cancer. Leclerc, Vincent, and Vandevenne in 1991 reported that nitrates from water are supposedly precursors of carcinogenic N-nitroso compound (NOC) formed within the organism. The result of a study conducted in China (Xu, Song, Reed 1992) suggest that nitrates in drinking water probably play an important role in gastric carcinogenesis. Increase in the use of nitrogen fertilizers increases the risk of nitrate contamination in many countries. In DCs, seepage from septic tanks and pit latrines also produce high nitrate levels in the groundwater.

Pesticides

Groundwater is especially susceptible to contamination by pesticides that are mobile in soil such as aldicarb, arrazine, bentazone, carbofuran, isoproturon, ethylene dibromide, and simazine. Pesticide concentrations in many groundwater sources now exceed WHO guideline values. Some of these pesticides are believed to be carcinogenic to humans, but all are of concern with respect to future generations because of their persistence in soil and water.

Risk factor for water-washed diseases

Geographical location of residence

Water-washed diseases are common among people where there is lack of water. When people use very little water, either because of non-availability or because it is too far away to be carried home in sufficient quantities, it is difficult to maintain personal and environmental hygiene and they are prone to various skin and eye infections. Eye diseases are a particular problem in arid regions where the drying effect of the air on the conjunctiva is combined with dust and sand and the scarcity of domestic water.

Risk factors for water-based diseases

Period of water contact

Schistosomiasis, the main water contact disease (also known as bilharziasis) is a problem in tropical countries with inadequate waste disposal system. About 200 million people in 74 tropical countries acquire this infection from bathing or wading in infested rivers, lakes, and irrigation systems. Their daily work brings them in contact with infested water. The risk of exposure to schistosomiasis is higher in rural areas.

Gender

Women performing domestic activities are at greater risk of contracting infection because of longer periods of contact with water. A study reported that about 60% of pregnant women and 80% of the adolescent girls had contact with canal water during household activities and field work. The consequence of the disease also varies with gender. In women it may lead to female genital schistomiasis (FGS), which has more adverse effects. Women with FGS are at risk of developing tumours in the vulva (Box 7). This disease is of major concern in the African countries.

Box 7

Female genital schistosomiasis due to *Schistosoma haematobium*. Clinical and parasitological findings in women in rural Malawi

A total of 51 women with urinary schistosomiasis were examined in order to identify diagnostic indicators for FGS. Patients were selected at random from the outpatient department of the Mangochi District Hospital, Malawi. Medical histories were recorded according to a pre-designed questionnaire, and women were subjected to a thorough gynaecological examination including colposcopy and photographic documentation of lesions. Microscopy of genital biopsies revealed that 33 of the 51 women had *S.haematobium* ova in cervix, vagina, and/or vulva in addition to the presence of ova in urine. The most sensitive diagnostic procedure was microscopic examination of wet cervix biopsy crushed between two glass slides, which revealed 25 of the 33 genital infections. There was a significant correlation between the size of genital lesions and the number of ova counted per sq. mm of the crushed tissue. Women with FGS had significantly more tumours in the vulva than women with schistosomiasis limited to the urinary tract. Most of the observed genital pathology could easily be identified by the naked eye, but colposcopic examination yielded valuable additional information like the demonstration of neovascularization around cervical sandy patches. Few of the symptoms previously regarded as indicators for FGS could be linked to the presence of *Schistosome* ova in genital tissue. Husbands of infertile women with FGS had children with other women significantly more often than husbands of women who only had urinary schistosomiasis. This, together with the finding that the majority of the divorced women had FGS, indicates that the manifestation of this disease may have implications for the marital and sexual life of the affected women.

Source. Kjetland et al. 1996.

Dam construction

Water development projects, especially large-scale irrigation systems that are intended to boost agricultural output can spread the disease to previously unaffected areas. For example, dam construction in three African river deltas – the Nile, the Senegal, and the Volta – has led to increased risk of schistosomiasis in these areas. In China, the Institute of Parasitic Diseases of the Chinese Academy of Preventive Medicine, under the guidance of the Chinese Ministry of Health, completed a nationwide survey of more than one million people showing high prevalence and intensity of intestinal nematode infections; prevalence can sometimes exceed 50% in the Yangtze River valley provinces. The study indicated that the construction of these three Gorges Super Dam

may promote the emergence and re-emergence of new helminths and their snail vectors.

Risk factors for water-related insect vector-borne diseases

According to the World Health Report 1996, about a half of the world's population is at risk of insect-borne diseases. The risk factors for the spread of insect-borne diseases are international travel, trade, and migration. In addition, expanding agriculture, clearing of forests, building of dams and irrigation schemes, and unplanned urban development provide mosquitoes with new breeding grounds, while at the same time bringing more people into contact with them. The mosquitoes carry the *Plasmodium* parasite, which causes malaria. Changes in climatic conditions are enabling mosquitoes and other disease-carrying insects to survive and breed at more northern latitudes and higher altitudes. At greatest risk of dying from the disease are children under five in malaria-endemic areas; pregnant women; people moving from non-malarial to malarial zones for reasons of work, migration, refuge, war or tourism; and travellers who visit endemic countries and return home infected with the disease.

Dengue fever, a severe influenza-like illness, and dengue haemorrhagic fever are different manifestations of the same disease caused by four distinct viruses transmitted by *Aedes aegypti* mosquitoes. Dengue is the world's most widespread mosquito-borne viral disease. A total of 2500 million people worldwide are at risk of infection. An estimated 20 million cases occur each year, of whom 500 000 need to be hospitalized. Dengue epidemics are increasing due to expanding mosquito breeding sites in urban and peri-urban areas, and rapid transportation which involves both the movement of infected people and the spread of dengue-carrying mosquitoes.

Yellow fever is a mosquito-borne viral disease, which is prevalent in the tropical regions of South America and Africa. It continues in a transmission cycle involving forest-dwelling mosquitoes and monkeys, often referred to as the 'jungle yellow fever'. The incidence of yellow fever is highest in parts of western Africa, including Ghana, Nigeria, and adjacent countries, and in northern South America, especially Peru, Bolivia, Brazil, and neighbouring countries. Rural populations are at the greatest risk, with most cases occurring among young adult males who enter the forests as part of their work.

Japanese encephalitis is another mosquito-borne viral disease. Its transmission cycle involves wild birds and domestic pigs as amplifying

hosts, and the most common mosquito vector is *Culex tritaeniorhyncus,* which is associated with rice-growing regions. In recent years, the disease has spread into new parts of Asia, perhaps as a result of increase in rice fields. About three-quarters of the cases occur in Western Pacific, primarily in China and adjacent countries, with the remaining occurring in south-east Asia, especially India. The disease is rare in other parts of the world, and when seen, is generally associated with travellers returning from endemic areas.

Estimates of population at risk

From the data on access to safe drinking water and sanitation services, it has been estimated that about 2030–2110 million people are at risk of water-borne diseases. About 260–270 million children under the age of four are at risk of diarrhoeal diseases, most of whom live in least developed and developing countries. About 50–80 million children in India are at risk.

Table 8 shows the estimated population at risk due to some W&S related diseases.

Table 8
Estimates of population at risk due to W&S related diseases

Disease	Population at risk (in million)
Malaria	2020
Dracunculiasis	100
Schistosomiasis	600
Food-borne trematode infection	730
Intestinal parasites	4000
Lymphatic filariasis	1100
Onchocerciasis	120
Leishmaniasis	350
Dengue and dengue haemorrhagic fever	2500–3000
Sleeping sickness	55

Source. WHO 1997.

Epidemiological data/knowledge

In the World Health Report (1996), it is reported that diarrhoeal diseases caused more than 3 million deaths in 1995, of which more

than 80% were among children under age five. About 50% of diarrhoeal deaths are due to acute watery diarrhoea, 35% due to persistent diarrhoea, and 15% due to dysentery.

About 200 million people in Asia, Africa, and Latin America have symptoms of intestinal infections due to *Giardia*; there are some 500 000 new cases a year, the vast majority of them are children. The infection causes acute and persistent diarrhoea, abdominal pain, and rapid weight loss. Lack of sanitation and poor basic hygiene assist its spread. The main mode of transmission is in water contaminated by faeces. The disease has become a serious problem in day-care centres in the developed countries.

Epidemics of cholera and dysentery are frequent, striking adults and children. Cholera alone causes 120 000 deaths a year, and is particularly deadly in Africa, where epidemics have become more widespread and frequent since the 1970s, and death rates among sufferers are generally the highest. Seventy-nine million people are estimated to be currently under risk of cholera infection in Africa. A substantial proportion of cases and deaths have been among the displaced and refugee population in Somalia and Zaire. A pattern of global cholera epidemics – called pandemic – that literally circle the world is being repeated. At least seven such pandemics have been recorded in the last 150 years. The seventh pandemic of the disease caused by *Vibrio cholerae* of biotype El Tor, which started in 1961 in Indonesia, spread to Peru in 1991, and then to other countries in South and Central America. In 1993, cholera was reported as endemic in some 80 countries, affecting several thousands of people.

A new strain of El Tor cholera, O139, emerged in India in 1992. It spread west towards Pakistan and east towards China, and in the early months of 1993, caused an estimated 100 000 cases and 1000 deaths in southern Bangladesh. It has not spread rapidly since then, but yet remains a threat.

The economic impact of cholera epidemics, in losses of trade and tourism, can be enormous. For example, the 1991 epidemic in Peru cost that country a loss estimated at US $770 million, almost a fifth of its total exports in a normal year (Box 8).

Several countries, especially in Africa, have to cope with the emerging problem of recurrent epidemics of 'bacillary dysentery'. The spread of epidemic dysentery started in 1979 in eastern Zaire and since then has invaded all African countries. For several months in 1994, dysentery was the main cause of death in refugee camps in Burundi, United Republic of Tanzania, and Zaire. Epidemic dysentery is also seen in Asia and Latin America.

Box 8

Cholera: a consequence of unsanitary conditions

The cholera epidemic that began in Peru in 1990 and spread to 16 other countries in Latin America is the most striking demonstration in recent history of the health effects of lack of sanitation facilities, safe drinking water, and poor food hygiene. *Vibrio cholerae* – the pathogen that causes cholera – is thought to have reached the Peruvian coast in a contaminated ship's hull or via contaminated sea plankton. Coastal shellfish and fish were contaminated and people who consumed these got infected themselves. A total of 378 488 cholera cases were reported in Latin America during 1991, most of them in Peru. By 1995, the number of new cases were decreasing. But the epidemic still prevails throughout the continent, with 85 809 cases reported by 15 countries in 1995. Cholera incidence in the Americas represented 41% of all cholera cases officially reported to WHO that year.

In Peru, where the outbreak was most severe, the abrupt halt in tourism and agricultural exports cost the Peruvian economy US $1000 million in just 10 weeks. The total economic cost to Peru was more than three times the total national investment in water supply and sanitation improvements made in the 1980s. Cholera is a worldwide problem. A total of 208 755 cholera cases and 5034 deaths were officially reported to WHO in 1995. The number of cases reported from Africa in 1995, totalling 74 105 including 3024 deaths, represented about 34% of all cases.

Although cholera incidence is falling in all regions, the epidemic is expected to persist in the long term if water supply and sanitation problems in the developing world remain unsolved. Cholera can only be prevented by ensuring that all populations have access to adequate excreta disposal systems and safe drinking water. Special attention should be paid to refugee camps where large concentrations of people and poor hygienic conditions combine to generate major health risks. In Zaire, for example, 58 057 cases of cholera were reported in 1994. Most of these cholera cases occurred in refugee camps near the Rwandan border and could have been avoided by ensuring safe potable water, adequate means of excreta disposal, and safe food. A dramatic decrease in Zaire to 553 cases in 1995 reflected the stabilization of refugee movement.

Source. World Bank 1992; WHO 1996 b.

Typhoid fever causes about 16 million cases and more than 60 000 deaths a year. Almost 80% of cases and deaths are in Asia, and the remaining occur in Africa and Latin America. The socio-economic impact of the disease is huge, because typhoid survivors take several months to recover and resume work.

Epidemic of hepatitis due to HEV is an ecologically determined disease, largely associated with faecal contamination of drinking water.

It has been reported in numerous environmental settings, including areas where drinking water sources such as rivers, streams, and open wells are situated in close proximity to open drains and contaminated surface water, and areas where leaking water pipes run through polluted water and land, and among crowded living conditions. Slums and refugee camps, where water supply is poor and waste disposal systems inadequate, are especially vulnerable. This disease commonly occurs during monsoons and floods, when water supply and waste disposal systems are likely to be disrupted.

In India, hepatitis due to HEV is responsible for 87% of cases of subacute hepatic failure, for 58% of cases of acute fulminant hepatic failure and acute sporadic viral hepatitis, and nearly all epidemics of viral hepatitis. Other countries reporting outbreaks due to HEV include Mexico, Myanmar, Indonesia, Nepal, Thailand, and various African countries. Outbreaks of hepatitis occurred in the Kathmandu valley area, Nepal in 1973. Infection was predominant in young adults and high case-fatality rates among pregnant women. In 1980/81, there was a prolonged epidemic of hepatitis in this area, peaking during monsoons; 70% of the cases occurred in the 15–35 age group with a case-fatality as high as 21% in pregnant women.

In Algeria during 1980/81, hepatitis and typhoid outbreaks were reported following rains, flooding, and due to contamination of water supplies. In 1985/86, hepatitis was also identified in refugee camps in Ethiopia, Somalia, and Sudan. These outbreaks usually appeared six to seven weeks after the onset of rains, which under refugee camp conditions, created a favourable environment for faecal–oral transmission of enterically transmitted infections. Again, young adults were mainly affected and high case-fatality was in pregnant women.

Schistosomiasis, another water-contaminated disease also known as bilharziasis, leads to chronic ill-health. About 200 million people in 74 tropical countries have acquired this infection from bathing or wading in infested rivers, lakes and irrigation systems, and 500–600 million people are at risk. The parasitic flatworm or blood flukes called schistosome, penetrate the skin, enter the blood stream of human beings, and develop into worms that inhabit the blood vessels of the intestines or bladder. The female worms lay hundreds of eggs in the blood vessels every day for an average of five years, and it is the eggs rather than the worms that damage the intestines, bladder, and other organs. The disease causes some 20 000 deaths a year and can lead to a form of bladder cancer which is the primary cause of death among men under 44 years in Egypt. It also takes a high toll in many parts of Africa. The social stigma attached to *S. haematobium*, in

conjunction with financial limitations, discourages infected women from seeking medical help. It is, therefore, likely that urino-genital schistosomiasis infection in women is significantly under-reported in many societies (Box 9).

The disease is also being spread by mass migration from the countryside to urban centres, and has become a serious problem in some big cities of Africa and Brazil.

Box 9
Implications of *Schistosomiasis haematobium* in women

Schistosomiasis is contracted by the passage of the parasite through the skin in water. It is the second most prevalent parasitic disease in Africa, following malaria. It is generally accepted epidemiological wisdom that the prevalence of urinary schistosomiasis is higher in men than in women. The disease burden of schistosomiasis is not reflected by prevalence data. However, even if prevalence is higher in men, those women who are infected may bear an additional disease burden due to both physical and social morbidity (genital lesions and stigmatization). Severity of disease is related to the intensity of infection, which is mainly determined by frequency of exposure. It is not known whether prolonged, low-level exposure has a cumulative effect. Recent investigations of the social implications of the disease for women suggest that urinary schistosomiasis may be a neglected and under-reported health problem.

Two studies on urinary schistosomiasis in women undertaken in Cameroon and Nigeria reveal oft-neglected social dimensions of the disease which need to be taken into consideration while evaluating the impact of this disease on individuals and communities.

In a village in Cameroon, prevalence of schistosomiasis was found to be 76% with slightly more women infected than men. While the egg count diminished with age in males, there was little difference in egg count among females between 5 and 44 years of age. Over 44 years of age, a significantly lower egg count in both sexes was noted. In a study carried out in a rural area of Nigeria, (population 20 000) 71% of all water-related activities are carried out by women. Children aged from 5 to 14 years had the highest prevalence of infection (72%). Prevalence in adults was 54%. Females were found to have a more stable infection status than males. In this Nigerian community, 80% of the households are polygamous and husbands do not provide full support. Loss of productivity through urinary schistosomiasis infection therefore has serious implications for family income.

Both studies attributed women's infection rates to their gender-assigned domestic and agricultural responsibilities; these include water collection, bathing of children, laundering, cleaning of utensils, preparation and washing of foodstuffs, and farming, all of which involve regular and prolonged exposure to infected water. Inadequate sanitary disposal systems, lack of basic amenities, and lack of awareness concerning sources of infection and transmission were also identified as causal factors.

Source. WHO 1994.

Dracunculiasis (guinea-worm disease) is the only parasitic disease that may be totally eradicated from the world in the near future. Although widely distributed at the beginning of the 20th century, the disease is now found only in sub-Saharan Africa, and the Arabian peninsula. In India, no case was reported during 1997. This shows that the country is fast moving towards its eradication. It is still endemic in 18 countries, of which 16 are in Africa and 10 in the category of least developed countries. Approximately 122 000 cases were reported from fewer than 8000 endemic villages in 1995, as compared with 3.5 million in 1986 and 1 million in 1989. This parasitic disease is transmitted by drinking polluted water in regions where water is scarce. It affects men, women, and children equally and has adverse effects on health, agricultural production, and school attendance. Extremely painful and debilitating, it can affect 50% or more of the population in areas where the disease is endemic. Incapacity results from pain and secondary infections associated with the emergence of guinea worms (which are 60–100 cm long and 0.2 cm in diameter) through the skin of the hands, feet or other parts of the body. Those affected do not develop immunity, so people may suffer repeatedly from the disease.

No medicines or vaccines are available to prevent or cure this parasitic disease; however, dracunculiasis is extremely easy to combat. Global inputs have been mobilized to eradicate the diseases soon. The population at risk of infection is estimated at 120 million in Africa and 10 million in Asia. So the fight must continue, and even reinforced, because the last cases are to be found in the most inaccessible areas.

Link between cause and effects

The direct effects of improved W&S services on health are seen in the case of water-related diseases. Infant and child mortality rate *vis-à-vis* access to safe drinking water and sanitation services in six countries are given in Table 9, indicating a high infant and child mortality in countries with lack of safe drinking water and sanitation facilities.

Malaria and low birth weight

Malaria during pregnancy leads to various adverse outcomes of pregnancy, among which low birth weight (LBW) is common. In much of sub-Saharan Africa, stable transmission of malaria is the rule, and women of child-bearing age have acquired a relatively high degree of immunity to the parasite through repeated exposure. Women demonstrate an increased susceptibility to malaria particularly in the

Table 9
Infant and child mortality rate and access to safe drinking water and sanitation services

Country	Infant mortality rate (0–1 year) (per 1000)	Child mortality (0–5 years cumulative (per 1000)	Access to safe water (% of population)	Access to adequate sanitation (% of population)
Sweden	5	6	100	100
Chile	15	17	96	71
The Philippines	39	48	84	75
Ghana	77	113	56	42
Guinea-Bissau	135	207	57	20
Afghanistan	159	251	10	8

Source. WHO 1996 a.

first pregnancy. In subsequent pregnancies, women generally do not have a higher risk than non-pregnant women of similar age. Despite the acquired immunity in these women, the placenta apparently provides a protected site for the parasite's development and replication. While the mother may experience no symptoms, the potential local effects of altered nutrient transport across the placenta, and the passage of infected red blood cells to the foetus, may disturb foetal growth and survival of the newborn infant (Box 10).

Water resource development and schistosomiasis

The occurrence of schistosomiasis may be greatly influenced by water development projects. Irrigation systems, storage dams for water supplies and hydro power plants, fisheries, etc. may actually increase the risk by creating favourable environment to the parasites and intermediate snail hosts (Table 10).

DALYs and health costs

Disability-Adjusted Life Years (DALYs) is a composite measure of the time lost due to premature mortality and time lived with disability. The number of DALYs in different regions indicate the relative distribution of disease burden. Higher DALYs indicate greater burden of the disease.

Globally, 23% of DALYs are caused by infectious and parasitic diseases, but it varies enormously from region to region. The lowest

Box 10
Malarial infection and birthweight in urban Zanzibar, Tanzania

In urban Zanzibar, Tanzania, about 389 women with full-term pregnancies were studied to see what effect their infection with malaria (at delivery) had on the birth weight (BW) of their infants. The overall prevalence of low birth weight (LBW) (i.e. <2500 g) was 3.9% (15 out of 389). Overall, 21.3% of the women only had peripheral parasitaemias at delivery, 17.6% only had active placental infections, and 47.9% had both. The youngest women (<20 years), the primiparae and those with *Plasmodium* infection gave birth to neonates with relatively low mean BW. The lowest mean BW (2967 g) was found among the offspring of women with active placental infection (N = 58). The women with past/chronic infection (N = 73) or no infection (N = 201) generally produced heavier infants, with mean BW of 3242 and 3338 g, respectively. The women with active placental infection were also far more likely to have babies of LBW (15.5%) than those with past/chronic infection (1.4%) or no infection (1.5%). Multi-variate analysis indicated that the highest relative risk of LBW (10.1, with a 95% confidence interval of 2.9–35.4) was associated with active placental infection, with no significant difference between primiparae and multiparae. In the study population, therefore, with its low prevalence of LBW, malaria infection increased the risk of LBW in full-term neonates by about tenfold, with a population-attributable proportion of 55.4%.

Source. Matteelli et al. 1996.

Table 10
Example of increased prevalence of schistosomiasis resulting from water resource development activities

Country	Project (completion year)	Pre-project prevalence (%)	Post-project prevalence (%)
Egypt	Aswan dam (1900)	6	60 (3 years later)
Sudan	Gezira scheme (1925)	0	30–60 (15 years later)
Tanzania	Arusha Chini (1937)	low	53–86 (30 years later)
Zambia and Zimbabwe	Lake Kariba	0	16 adults, 69 children (10 years later)
Ghana	Volta lake (1969)	low	90 (2 years later)
Nigeria	Lake Kainji (1969)	low	31 (1 year later) 45 (2 years later)
Iran	Dez pilot irrigation project	15	27 (2 years later)

Source. Silverberg 1994.

value of DALYs due to infectious and parasitic diseases is 2.7% in Formerly Socialist Economies of Europe, and the highest, 43% is in sub-Saharan Africa (Table 11).

Table 11
Percentage distribution of DALYs due to infectious and parasitic diseases in various regions

Region	% DALY due to infectious and parasitic infection
Established Market Economies	2.8
Formerly Socialist Economies of Europe	2.7
India	28.9
China	7.5
Other Asian Islands	22.3
Sub-Saharan Africa	42.5
Latin America and Caribbean	17.6
Middle-eastern Crescent	20.2

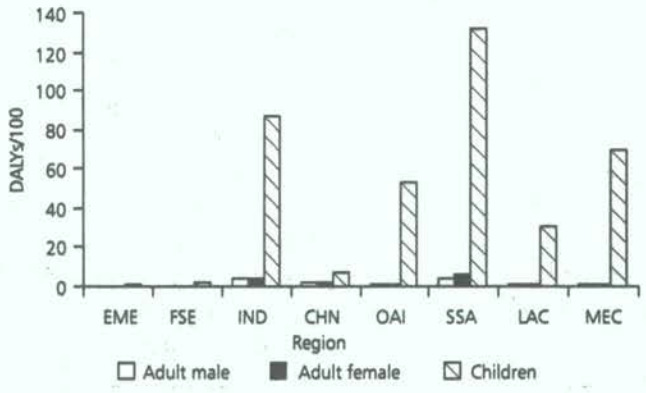
Source. Murray, Lopez 1996.

As per the estimated contribution of 10 major risk factors to the global burden of diseases in 1990, W&S combined together is the second major risk factor responsible for about seven per cent DALYs. Exposure to poor water supply and sanitation increases the risk of diarrhoeal diseases. Among various regions, the largest proportionate impact of W&S on DALYs is in sub-Saharan Africa and India, where unsafe water, poor sanitation and personal hygiene are estimated to have caused about 10% of DALYs in 1990. The impact of this exposure is less in established market economies and formerly socialist economies of Europe. Children and adult males and females affected by W&S related diseases are given in the form of DALYs per 1000 persons (Table 12) . The table shows that children in DCs are worst affected. In adults, the DALYs rate is slightly higher in females than in males for some cases. Among all W&S related diseases, the DALYs are high for diarrhoeal diseases.

Figure 4 shows the relationship between the level of economic development and DALYs in diarrhoeal diseases in various regions. It is also estimated that about 90% of the current diarrhoeal and malarial disease burden could be avoided if environmental conditions such as safe water supply and sanitation services are improved (WHO 1997).

Figure 4

Diarrhoeal diseases among males, females, and children in various regions – DALYs per 1000



Source. Murray, Lopez 1996

Note. EME–Established Market Economies; FSE–Formerly Socialist Economies; IND–India; CHN–China; OAI–Other Asian Islands; SSA–Sub-Saharan Africa; LAC–Latin America and Caribbean; MEC–Middle Eastern Crescent

Table 12

Burden of disease attributable to poor water supply and sanitation among children and adult males and adult females in 1990 – DALYs per 1000 persons

	Diarrhoea			Malaria			Dengue			J.encephalitis			Int. Nematode			Trachoma		
Region	AM[1]	AF[2]	CH[3]	AM	AF	CH	AM	AF	CH	AM	AF	CH	AM	AF	CH	AM	AF	CH
EME	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0
FSE	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0
IND	4	4	87	1	1	2	0	0	1	0	0	0	1	1	1	0.0	0.1	0
CHN	2	2	7	0	0	0	0	0	0	0	0	1	0	0	4	0.2	0.6	0
OAI	1	2	53	3	3	5	0	0	1	0	0	1	1	1	5	0.1	0.2	0
SSA	4	6	132	8	9	106	0	0	0	0	0	0	1	1	1	0.7	1.9	0
LAC	1	1	31	1	1	1	0	0	0	0	0	0	0	0	3	0.0	0.0	0
MEC	1	1	70	1	1	1	0	0	0	0	0	0	0	0	1	0.5	1.2	0

Source. Murray, Lopez 1996

AM–Adult male; AF–Adult female; CH–Children; EME–Established Market Economies; FSE–Formerly Socialist Economies; IND–India; CHN–China; OAI–Other Asian Islands; SSA–Sub-Saharan Africa; LAC–Latin America and Caribbean; MEC–Middle Eastern Crescent

New emerging diseases

'Emerging' infectious diseases can be defined as infections that have newly appeared in the population or had existed but are rapidly increasing in incidence or geographic range. Some of the emerging diseases in relation to water are prolonged diarrhoeal diseases due to water-borne *Cryptosporidium*, haemorrhagic colitis, and renal failure from E.coli O157:H7. The incidence of mosquito-borne diseases, including malaria, dengue, viral encephalitis, and new strains of cholera are emerging in new areas. This is mainly due to the environmental and behavioural changes. During the past 20 years, about 30 new diseases have emerged. Environmental changes have contributed in one or another way to the appearance of most of these diseases. Human activity such as cutting down of forests and conversion of grassland to agricultural lands has contributed to environmental changes. Simple behavioural changes such as careless disposal of food and beverage containers and motor vehicle tyres in the urban environment favour the spread of vector-breeding sites.

The outbreak of severe haemorrhagic fever in Venezuela in late 1989 was one such case where the disease emerged due to the changing environmental condition. The etiologic agent was named 'Guanarito virus'. Chronically infected cotton rats are believed to serve as the source of infection for humans. In this instance, land-use changes including clearance of forest for agriculture provided more favourable habitats for food sources for rats, and influxes of seasonal workers, combined to create the ideal conditions for an outbreak.

A new breed of deadly haemorrhagic fevers, of which Ebola is the most notorious has struck in Africa, Asia, the United States, and Latin America. Ebola appeared for the first time in Zaire and Sudan in 1976; it has since struck Cote d'Ivoire in 1994 and 1995, Liberia in 1995 and again Zaire in 1995, where it was fatal in 77% of the cases (Box 11).

Epidemics of food-borne and water-borne diseases due to new organisms such as *Cryptosporidium* or new strains of bacteria such as *Escherichia coli* have hit industrialized and DCs alike. The O157:H7 strain of *E.coli* was first reported in 1982 and has since been implicated in serious outbreaks of diarrhoeal illness, sometimes leading to kidney failure. Three outbreaks of disease in the United States in 1993 caused by *E.coli* O157:H7, Cryptosporidium organisms, and a previously unrecognized hantavirus.

According to Khera, Jain, and Dutta (1996), water-borne and water-related epidemics constituted more than 70% of the epidemics

in India. NON O1 cholera epidemics constituted one-quarter of cholera epidemics during 1991–95. A completely new strain of cholera, O139, appeared in south-eastern Asia. In India, plague in Beed and pneumonic plague in Surat re-emerged in 1994.

Box 11

The Ebola epidemic: a model for rapid response

The epidemics of Ebola haemorrhagic fever in Zaire in mid-1995 focused international attention on emerging diseases to an almost unprecedented degree, even though the number of people affected – 316 cases including 245 deaths – was little compared to many other infectious diseases.

The intense public and media interest in Ebola haemorrhagic fever was stirred by its deadliness – its infectiousness, and its dreadful symptoms – the epidemic had a 77% mortality rate. The average age of victims was 35 years; patients ranged from a three-day-old baby to a 71-year old man. Many of the victims were health care workers. Despite fears that the disease might spread to other parts of the world, the epidemic was confined to a relative small core of Zaire.

This was due largely to the rapid national and international response to the outbreak. Staff from WHO headquarters in Geneva and regional office in Brazzaville, Congo arrived at the site of the epidemic within 24 hours of notification in Geneva. At the same time, diagnosis of the disease was confirmed by the WHO Collaborating Centre on Arboviruses and Viral Haemorrhagic Fevers, at the Centres for Disease Control and Prevention, in Atlanta, Georgia, USA.

By arriving promptly, WHO experts and their Zairian public health counterparts were able to set up a disease detection system and train medical students in its operation so that all cases could be found and isolated. As the international partners in outbreak investigation and control arrived, WHO's role became one of ensuring synergism among those partners, providing logistic support, and identifying and ensuring essential epidemic research. An International Scientific and Technical Committee, established in Zaire by the Zairian Health Ministry and WHO, directed the epidemic control operations and set up a follow-up surveillance system. Research efforts were made to identify the natural host of the Ebola virus. This and other recent outbreaks of infectious diseases highlight a weakened ability to detect and contain such threats at a national, regional, or global level. One lesson learned was that WHO can and must play a pro-active role to support national efforts to control outbreaks. It has therefore established a new rapid response system including teams of experts and supplies from regional offices, with headquarters support, to be available for immediate field operations at 24 hour's notice.

Source. WHO 1996 a.

Climatic factors influence the emergence and re-emergence of infectious diseases, in addition to multiple human, biological, and ecological determinants. The incidence of mosquito-borne diseases are most sensitive to climate change. Climate change directly affects disease transmission by shifting the vector's geographic range and increasing reproductive and biting rates, and by shortening the pathogen incubation period. Climate-related increase in sea surface temperature and sea-level rise can lead to higher incidence of water-borne infections and toxin-related illnesses such as cholera and shellfish poisoning. A study conducted to predict the health effects of climatic change and the possible consequences for Norway is given in Box 12.

Box 12
Health effects of climatic changes - possible consequences for Norway

In the year 2100, a global mean temperature increase of 2°C. and 50 cm rise in sea level are expected. An escalation in the intensity and duration of heat waves will increase mortality, whilst higher temperature in cold regions may reduce it. On a global scale, the incidence of vector-borne diseases such as malaria, dengue, yellow fever, and some types of viral encephalitis are likely to increase. About 50–80 million more cases of malaria could occur annually. Elevated temperatures and more frequent floods could cause an increase in salmonellosis, cholera, and giardiasis. Indirectly, shortage of freshwater and food may cause serious health problems. The world may see more environmental refugees. For Norway, a temperature increase of 3°C–4°C during winter and 2°C in summer is predicted, with more precipitation, especially in western parts. The possibility of the Gulf Stream turning at 40°N and causing a temperature decrease of 10°C, is not very likely. Malaria could re-establish itself in Europe, but hardly in Norway. The most harmful arthropod vector in Norway, the tick *Ixodes ricinus*, might extend its range into the most populated parts of the country. Increase in marine algal blooms might increase the risk of cholera. Health problems caused by greater floods, poisonous algae, and certain freshwater cercaria might increase.

Source. Ottesen, Lassen 1997.

Research need

Cost-effective interventions to prevent the spread of the disease exist; but the concern is on the emergence of drug resistance. An appropriate epidemiological surveillance and control activity for diseases should be established, and research for the development of better treatment

regimens and improved diagnostics, drugs, and vaccines should be promoted and supported. To ensure the protection of children against an ever-widening range of diseases, R&D of new and improved vaccines should be promoted and supported (Box 13). At the same time, there is a need to strengthen the capability for surveillance and control of infectious diseases in several countries that have been experiencing repeated epidemics outbreaks during the past few years. Such improvements should include the integration of clinical,

Box 13
New and improved vaccines for tomorrow's children

Every year, hundreds of millions of people, most of them infants, are protected by vaccines against deadly diseases of childhood and adulthood. As a result poliomyelitis, measles, and neonatal tetanus are likely to be eliminated within the next few years. The constant quest for new and improved vaccines offers the prospect of protecting children and adults of tomorrow against an ever-widening range of diseases.

WHO is actively supporting the R&D of both improved vaccines and completely new ones for diseases which so far have not been preventable by immunization. The latter category includes acute respiratory viral diseases, diarrhoeal diseases, bacterial meningitis, and tuberculosis, which kill millions of people every year and most of them children under five years of age.

Reports of work on some of the new or improved vaccines for W&S related diseases are given below.

Dengue and Japanese encephalitis

The aim is to accelerate the final development of attenuated dengue vaccines and genetically engineered dengue and Japanese encephalitis vaccines. Targets for 1998–2000 are to have one dengue vaccine evaluated for effectiveness, introduce it into immunization programmes in at least one country; and to have evaluated one new Japanese encephalitis vaccine in clinical trials.

Diarrhoeal diseases

Priority is being given to the development of vaccines against shigellosis and rotavirus diarrhoea. Research groups are working towards developing vaccines that are effective against both the recently isolated cholera strain 0139 and the more common 01 strain. Studies related to the potential use of cholera vaccines in refugee camps are being conducted. Vaccines against *E.coli* diarrhoea and typhoid are being developed. Shigellosis vaccines should be available by 1998–2000, and the evaluation of typhoid, *E.coli*, and cholera vaccines should be completed within the same period.

Source. WHO 1996 a.

epidemiological, and laboratory components. The determinants of major parasitic infections in women have never been studied systematically. The environmental, economic, socio-cultural, nutritional, genetic, biological, and immunological factors which determine schistosomiasis in women are largely unknown. Thus, there is a need for systematic and interdisciplinary investigations. There is a considerable gap in the knowledge on newly emerging diseases. Their natural history and factors responsible for spread are not clear. Rapid action is required on one hand, and a more calculated, long-term approach essential on the other. At the same time, there is a need for intensive research on new diseases and potential for preventing and controlling them.

Social, managerial, and technical aspects

Multidisciplinary role of women

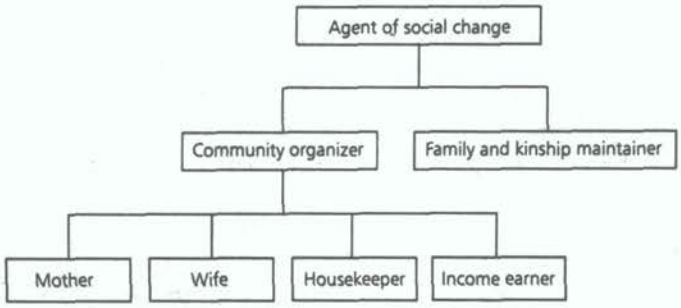
A woman's role as wife, mother, housekeeper, and income earner are well known and accepted worldwide. Figure 5 shows the multidisciplinary role of women at the domestic and the community level.

Woman's roles as community organizer and family and kinship maintainer have been the subject of research, mainly by anthropologists, but these are rarely considered by governments and planners while introducing new programmes in the community. Most developers especially those with patriarchal–patrilineal influence tend to address themselves to their male counterparts. Even professional women working in the rural community neglect these two roles which have been the essence of social maintenance.

As users, many women in DCs have direct contact with the natural environment as they collect essential items for their everyday household needs, water being one of them. Traditionally, they are the custodians and managers of water in the house, and play the main role in the management of water sources and environmental hygiene in their neighbourhood.

So far as health is concerned, women provide most health care to the family members. In a family, they prepare food and nourish children, clean the house and sweep the yard, and dispose children's excreta and other domestic wastes including cattle waste. They teach hygienic habits to the children and care for the sick in the family.

Figure 5
The multidisciplinary role of women



Source. O'Connel 1994.

Almost all traditional birth attendants and nurses are women. Thus, programmes on health and sanitation cannot succeed without women as they understand their own problems and can solve them.

Women are considered to be the best teachers and have potential influence on the family members, particularly children. They also have a high degree of tolerance and capacity to work. So their involvement is beneficial in three ways – as beneficiary, as mother or family member, and as motivator (O'Connel 1994). Considering the above aspects and also the need to remove imbalance by uplifting their social status, women's involvement in W&S services can become an entry point for many other developmental activities.

Water and sanitation - a gender approach

In the 20th WEDC conference on affordable W&S, Fernando V in the paper entitled 'Water and Sanitation- a gender approach', discussed in detail the concept of gender as applicable to the W&S sector.

In the beginning, W&S projects focused almost exclusively on physical works. This thinking changed fast and community participation was identified as the key to the success of W&S projects. But community participation became a male affair and women had no active role. They became 'users' or 'target groups' for health education with the community, men being involved as leaders, committee members, and caretakers.

For greater efficiency and effectiveness of the W&S projects, it became quite clear in the 1980s that women needed to play a greater role. Their views had to be considered to and their participation was

Box 14
Traditional methods of water purification in India

For centuries, nature's various products and women's knowledge on their properties have provided the basis for making water safe for drinking in every home and village in India. Both oral and written traditional knowledge of these alternative methods of water treatment is still available. The *Susbruta Samhita* lists seven modes of purifying water, among which is the clarification of muddy water by natural coagulants such as the nuts of *nirmali* tree (clearing-nut tree C *Stryychnos potatorium*). The seeds of the *nirmali* tree are used to clear muddy water by rubbing them on the insides of vessels in which water is stored. Seeds of *honge* (*Pongamia glabra*) are similarly used. The drumstick tree (*Moringa oleifera*), which provides a very nutritious vegetable, produces seeds which are also used for water purification. This tree has travelled from India to Africa as a water purifier, and in Sudan, it is called the clarifier tree. *Moringa* seeds inhibit the growth of bacteria and fungi. Since drumstick is consumed as a vegetable, it does not create any risk of toxicity, as chemicals do. Other natural purifiers include *amla* (*Phylanthus emblica*), whose wood is used to clear small rain-ponds in the Indian peninsula. In Kerala, wells are cleared with burnt coconut shells. The *tulsi* (*Ocinum sanctum*) is a water purifier with anti-bacterial and insecticidal properties. Copper or brass pots are used by Indian women to fetch water from the source, and for storage; unlike plastic, which breeds bacteria, they have antiseptic properties. In Ayurvedic medicine, small doses of specially prepared copper powder are ingredients of medicine used for diarrhoea, cholera, and typhoid. The technologies women have used for water purification are based on locally available natural products and locally and commonly available knowledge. Women use *honge*, *nirmali*, and drumstick trees in the safe and easy cure of everyday illnesses like diarrhoea, which can otherwise be fatal.

Source. Sontheimer 1991.

vital if W&S projects were to bring extra benefits for the community and women. The realization of the value of women's participation created a demand among projects for practical guidelines and how they could be brought effectively into the planning, implementation, and maintenance processes. These guidelines proved very effective worldwide, and many projects and programmes had glowing stories of the effectiveness of projects with active and women's full participation.

Where were the men now? There was a tendency to ignore the roles of men and this meant that focusing more on women's roles reduced the responsibilities of the men. Extra focus on women also overburdened them as they already had their hands full. It also

brought about cultural problems. The need for women and men to share the decision-making, work, and functions equally was becoming apparent, resulting in what we now call a 'gender approach' or more appropriately, the approach for 'sustainable human development concerns'. Gender approach means that the aptitudes, roles, and responsibilities of both men and women are taken into account requiring an open mind and aiming at the fullest participation of both women and men. Here two concepts are seen – women's involvement and the gender approach. Gender approach envisages a situation with more equality and justice, also taking into account the existing aptitudes, roles, and responsibilities of women and men. This approach gives more opportunities for women, make them share their burdens, and recognize themselves as equal partners in the family (Fernando 1994).

Objectives for involvement of women

Women need to be involved in the management of services since they are primarily concerned with water collection (Box 14). It would also enable understanding their choices and conveniences. A study by Sontheimer (1991), has focused on the rationale for women's involvement and their role in managing W&S facilities.

Choice and convenience of primary users

Women need to be taken into confidence while selecting the source, location of structures, and implementation of the project. Setting up W&S facilities nearer their houses diminishes drudgery of women and saves considerable time and energy which otherwise is spent in walking long distances. This time could be fruitfully utilized for some productive work which can uplift their status, enhance their lifestyle, and bring about betterment of the conditions of their families.

Sustainability of the W&S systems

Sustainability of the W&S systems can be ensured only through satisfactory operation and maintenance (O&M). Men go out of villages to work and for other purposes but women are available in the villages most of the time. So they need to be involved in the O&M of the system. Doing so, they will take care of equal distribution of resources or facilities to all sections of the society, protect the assets, and attend to minor repair works.

Availing maximum benefits

For utilizing their abilities and influence regarding health and hygiene aspects, women need to be motivated to participate in the health and

sanitation programmes. This will help reduce pollution and misuse of water resulting in reduction of water-borne diseases. For want of sanitation facilities in rural areas, women are facing lot of difficulties in defecation and taking bath. Avoiding nature's call till onset of darkness causes health problems. Similarly non-availability of bathing places forces them to avoid taking baths causing many skin diseases. Hence women need to be oriented towards the use of toilets and bathrooms.

Current gender imbalance

The status of women is significantly low, resulting in many disadvantages and limitations. The present circumstances prevent them from participating freely and fully in the development programmes and in improving their own life. Their activities and responsibilities are mostly confined to the household.

Low literacy level

Girls are usually engaged in household activities and not sent to school. So the literacy rate among women is very low in rural areas. Without proper education women cannot appreciate the importance of safe water and clean environment. The new technologies could also be unknown to them, as they remain the domain of men. Thus, women are deprived of the technological developments and their use in reducing the drudgery and suffering.

Water supply and sanitation activities taken for granted

Despite their important and multiple roles, women are currently not adequately involved in the IDWSSD activities. Not enough attention has been given to women as the primary human resource and the ultimate users of water. Their water-related work is taken for granted and they are denied economic and social value. Most women do not have sufficient water for daily needs; if it is in short supply, it might be polluted and will cause ill-health for women, and their entire families and communities.

Excluded from decision-making and planning

Due to a predominantly male-dominated society, women have less power and authority to take decisions. Decisions outside the home are mostly taken by men. No properties are transferred on their name and no credits given to women. This state of affairs deprives them of any authority or confidence to manage independently.

Women are often excluded from the planning and implementation of W&S projects. Such projects may lack elements of communication and information on women. The relationship between water, sanitation, and health practices are essential if W&S facilities are to improve general health (Box 15). W&S technologies often do not consider the cultural context and level of know-how of the communities, nor are they cognizant of women's needs, interests, and skills. Lack of consultation with women regarding technical aspects and site selection results in impractical solutions and overall failure of expensive W&S facilities: pump handles, for instance, may be too heavy or placed too high for women and children to reach them (Sontheimer 1991).

Biased social custom and traditions

Some customs and traditions forbid women from communicating with male members. They are not allowed to attend evening meetings or outstation visits. And even if they attend the meetings, they do not speak out in the open. Thus their difficulties remain untold and unsolved. Similarly, socio-cultural traditions and prejudices have sex-specific beliefs. These limitations remain as severe constraints while involving women in W&S programmes.

Due to the stigma attached with menstruation, in many places, women and men are not allowed to defecate and bathe at the same place. Women have to defecate at night only for reasons of privacy, thus depriving them of the benefit of basic services. Due to untouchability and other taboos, women of backward communities are not allowed to use public facilities. Moreover, local women's customs, preferences, and traditions are not considered in selecting the technical design and location of project. For example, in some places women do not wish to wash themselves in public, and yet male engineers often place the pumps in the village square, assuming it as the most convenient site (Sontheimer 1991).

Women's task force

Until the UN Water Conference in 1977 and the IDWSSD, women's role as providers and managers of water was never considered by project planners either at the government or the local level. In 1982, a Task Force on Women under the IDWSSD was set up in recognition of the important role that women play in W&S activities. Initially, the United Nations Children's Fund (UNICEF) and the International Research and Training Institute for the Advancement of Women had the joint responsibility for the Task Force's secretariat. This role was

Box 15
Findings of survey on water-related gender problems, Gujarat, India

The Royal Netherlands Government is supporting the state government in providing safe water supply and sanitation facilities in acute problem areas. Three projects have been implemented with their financial support in water scarce, saline, and fluoride-prone areas.

In these areas, post-project implementation activities are also monitored with the support of non-governmental organizations (NGOs). With a view to knowing the gender specific problems and for their redressal, a survey of 300 women in 30 villages was carried out (1989) with the support of an NGO – Self Employed Womens Association. The findings of the survey are as follows.

- 78% women spend about four hours daily fetching water.
- Women walk a minimum of 6 km to fetch water.
- 53% of women in drought-prone areas complained that they could not bring sufficient water.
- 63% showed their readiness to learn water harvesting skills, banding, drip irrigation, afforestation, and desalination.
- 86% said that they dread their children and family members getting sick from water-borne diseases. They emphasized on a greater role in co-deciding the site, budget, formulation of schemes, and its O&M for water supply and sanitation facilities. The report has also provided the following information.
  - Due to migration of men to the cities in search of job opportunities, women have to take help from children in fetching water with the result that they miss school.
  - Women living in desert areas have to travel long distances in summer in an attempt to save their cattle from heat. During the journey, they lose large number of cattle.
  - Due to lack of safe and adequate W&S facilities many children die of diarrhoea and dehydration.
  - Resort to unsafe source of water results in sickness, diseases, and death, especially in children.

Source. Barot J M 1994.

later transferred in 1983, when UNDP launched an inter-regional project, the Promotion of the Role of Women in Water and Environmental Sanitation Services. This project focused on developing replicable models for involving community women in sustainable, effectively used, and environmentally-sound drinking W&S projects.

Between 1984 and 1986, the Task Force Member Agencies proposed a number of specific activities to involve women in operational country-level programmes. This included developing training courses for women volunteers in Sri Lanka. In Bangladesh, women volunteers from urban slums were trained on improved hygiene and health-related practices. A Kenyan organization trained community women in health education and handpump maintenance, and in Niger and Senegal, training was provided to women in irrigation techniques and repairs. Other areas of activity include workshops, publications of research and case studies, preparation of guidelines and training materials, and evaluation of the impact of water projects on women (Sontheimer 1991).

Women as managers of W&S projects

Solly Sontheimer in her book *Women and Environment* has given an account of the role women play as managers of W&S facilities as well as for the conservation of water resources. Women draw, store, utilize, and manage water as per the requirements of the family. Girls are also engaged in fetching water. Women also organize the disposal and reuse of waste water and have charge of sanitary arrangements (Box 16).

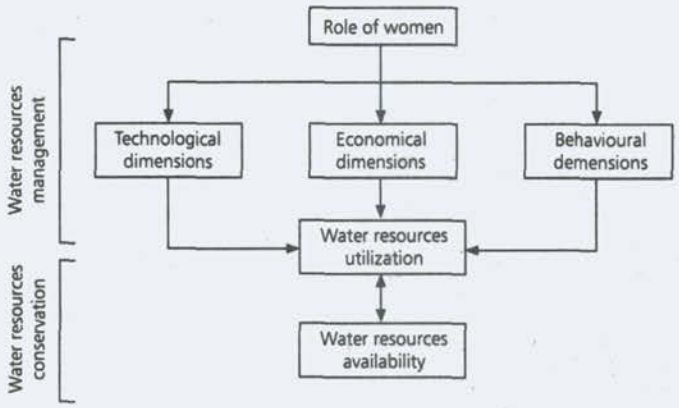
Box 16
Water quality

A study of women in Yemen shows that they use the best quality water, preferably from a spring, for drinking, personal washing, cooking, and cleansing drinking vessels, food, and flour-grinding stones. 'Grey' water is saved and used for washing clothes, cleaning floors, and given to poultry and cattle.

Source. Rodda 1994.

As managers of W&S facilities, women have an important role in the technical aspects and in providing appropriate guidance for the location and choice of technology. As agents of change they can influence the behavioural pattern and facilitate shift from age old customs and practices which prevent communities from using safe W&S facilities (Figure 6) to using safe drinking water and building healthy sanitation practices. Now women's organizations and grassroots groups have started taking initiatives for contributing to the

Figure 6
Water resources managerial processes



Adapted from Rodda 1994.

funding of W&S programmes. Sontheimer has given a detailed account of the technological behaviour and economic dimension of women's involvement in W&S programmes.

Technological dimensions

Here women's involvement should be in the form of sharing their expert knowledge of local water conditions which will be passed on to successive generations. This knowledge not only includes the location and availability of water sources, but also the social aspects.

Location of the technology

Women also have their own personal problems: they need privacy. If ablutions have to be done in the open, it is both embarrassing and unhygienic, and they are also exposed to the advances of men. Hence women need to play an important role in deciding the location of W&S facilities. Although it might seem like common sense to assess local people's needs before planning and implementing a project, this is not always done. In a project in Guinea-Baas, planners took the trouble to assess local people's need with great success. Villagers were trained as promoters to encourage other people to use the safe water supply. As the planners felt that promoters had to be respected in their communities, they chose women with children or older women. More people used the new wells in villages where promoters contacted women individually. The wells were also conveniently located, since

the people had influenced their location. And the fact that some villages were more concerned with irrigation for their rice fields or vegetable gardens than with drinking water was also taken into account. As a result, vegetable gardening flourished to the extent that seeds were sold in the village, improving women's income (Box 17).

Choice of technology

For projects to be successfully implemented, women must be consulted for their preferred choice of facilities for latrines, washing, watering animals, growing vegetables, etc. In rural Iran, the communal laundry facilities built were large rectangular sinks at adult waist height, whereas, Iranian women traditionally wash clothes and dishes in a squatting position. As a result, the laundry basins were left unused. In Acetin, Mexico, engineers recommended a squat-plate latrine instead of a pour-flush latrine because they felt that women would refuse to carry water from the standpipe to the latrine. However, it was found that women rejected the squat plate and preferred the pour-flush. Similarly, in Nicaragua, women refused to use a latrine because their feet were visible from the outside. These problems could have been avoided if they had been consulted prior to designing the latrines.

Box 17
Women earn the right to be heard

Women in Indonesia have proved to be skilled fund-raisers and committed supporters of W&S improvements, building on their traditional responsibility for managing household finances. In the village of Wonoanti, women established a number of fund-raising groups and made cash contributions each time the groups met. Once enough money had been raised, a lottery was held and the winning group was given the money to build water-seal latrines. This system continued until all groups benefited. In Kedompol village, CARE assisted the community to build 60 rainwater catchment tanks, serving 190 households. The local women were sufficiently impressed to organize fund-raising, and this has increased their influence over decision-making. More and more women are now forming committees and are being consulted on important community decisions.

Source. Evan, Appleton 1993.

Operation and maintenance

Maintenance is an inevitable requirement of any water-supply project. The failure of water supply systems can frequently be attributed to constant breakdowns due to lack of proper O&M. These break downs have resulted in frustration for women who are forced to walk even longer distances to another source or to revert to the traditional, and often polluted sources. Since many women are at home during the day, they are often the best suited to supervise the quality of maintenance work and protect facilities against vandalism and unintended or mischievous damage by children.

Government policy should, therefore, recognize the important role women can play in O&M and train them in those areas from the earliest stages of a project, as they come to know when a system is malfunctioning and is most affected by breakdowns. Again, because of their traditional role as providers of water for the family, women caretakers have expressed interest, enthusiasm, and ability to keep the water system working.

Backup support

In nearly all cultures, women provide backup support to construction workers in the form of food, water, and lodging. They motivate and support men to do unskilled voluntary construction work. In Latin America, Africa, and parts of Asia, women have willingly volunteered labour in the construction of facilities, especially piped water supplies. In Malawi, women provided up to 70% of the labour in most piped water schemes. In Panama, where a project trained and educated women to participate in the piped water system, they contributed by carrying heavy loads of sand and preparing food for labourers during construction. They were also involved in maintaining the system, and in several communities, they collected water fees, and in the process emerged as local leaders (Sontheimer 1991).

Behavioural dimensions

Sanitation promotion and education

The health benefits arising from improved water supplies may not be fully realized unless there are complementary inputs in the field of sanitation, since inadequate sanitation or sewage treatment plays a part in the transmission of many water-related infections. In Pakistan, integrated W&S programmes have been successful, partly because women have been trained as sanitation promoters. Their duty is to motivate and help promote latrine-building in the villages, while male strangers are not allowed to enter houses and talk to village women; the women promoters enter the houses with ease (Sontheimer 1991).

Box 18
Women as managers of W&S facilities

The recognition of the crucial role that women play in water management at the household level has recently led to projects such as those in Kenya and Bangladesh, summarized below, which demonstrate the merits of women's participation. Both projects recognized that women would not automatically become involved and that a determined effort was necessary to ensure their participation. The projects emphasized community participation and included primary roles for women, but not excluding men at the same time.

In the southern coastal area of Kenya, a project began in 1983 to develop and install a system for handpumps. Early problems prompted the organizers to bring in a local NGO specialized in developing self-help water systems and focusing on women's participation. Women were trained as extension workers and in community organizing and development. Both men and women were trained for appropriate maintenance and repairs. The local NGO motivated village men and women to organize themselves into water committees, which would be responsible for maintenance and repairs. By 1988, 135 village water committees were established, all of which had women as treasures. All of the pumps were functioning. Both men and women had gained greater self-confidence and had an increased respect for, and acceptance of, women in public decision-making. Between 1985 and 1987, diarrhoea declined by 50% and skin diseases by 70% in the project area. The project also resulted in savings for both government and the villages.

In Mirzapur, Bangladesh, a programme was created to install handpumps and latrines. Again, the project was community based, strongly emphasizing the inclusion of women. Women were involved from the beginning in selecting sites for handpumps and latrines. They helped to cure the cement for platforms and were trained to maintain both the pumps and the latrines. Women were also the main focus of the hygiene education programme. In the intervention area, 148 handpumps were installed (one for every 33 inhabitants) and 754 latrines built. Most (90%) of the households used the land outside the intervention area. Virtually all (98%) of the adult population said they used the latrines regularly. Within the intervention area, there was a noticeable decline in diarrhoea and other diseases. Essential to all of this was the strong participation of women.

Source. Rodda 1994.

Increased efficiency of community management

High level of women's participation in decision-making increases the effectiveness of community management projects. Although in some cases, for religious or cultural reasons, their involvement is not overt or apparent in organizational structures, they often play a highly

influential and beneficial role in the community management of water supplies. Women in Indonesia have proved to be particularly resourceful in raising funds for W&S improvements, and as a result have strengthened their position as decision-makers as well.

Adequate representation of women in community-managed water programmes cannot be taken for granted, and the advancement of women remains a development goal (Box 18). The growing number of women-headed households in DCs add urgency to this issue. Inhibiting factors are still proving hard to overcome, but innovative ideas are being developed for encouraging enhanced involvement of women in water programmes. Box 19 lists 10 steps to ensure that women play as full a part as possible in their programmes (Sontheimer 1991).

Women's organizations

National women's organizations can fulfil several functions on a large scale. They can monitor and campaign for increased government commitment to W&S programmes; advertise programme goals and activities in the media; provide assistance in recruiting women managers, engineers, and teachers; hold training workshops; and raise funds and support local women's groups with funds, equipment, technical backup, and information materials.

Water conservation

Water conservation techniques are crucial where water sources are scarce and applies to much of their developing world, located in arid and subtropical regions. Because women have high stakes in seeing that there is sufficient water, they can be motivated to support water conservation techniques that will improve the supply. In Burkina Faso, for example, women helped build earthen dams by collecting rocks and preparing the gravel and stones needed for construction.

Economical dimensions

Funding sources

While financing for W&S projects traditionally comes from governments, UN agencies, international development banks, national lending institutions, and women's organizations have also begun to take initiatives in providing innovative approaches to funding. In many cases, voluntary groups take tasks that are officially the government's responsibility. In a Tamil community in India, for example, a nursery-school teacher has been made the pump caretaker,

Box 19
Steps for women's involvement

The 10 key steps to enhance the involvement of women in W&S programmes are listed below. These steps can be taken by water agencies as a means of advancing women's involvement.

1. Orient male management and staff on how women's involvement would help realize project objectives.
2. Work with women field workers and the agency itself should be involved in the planning and management of water services.
3. Discuss with local leaders and authorities on the need for women involving in the planning and management of water services.
4. Inform women about project and programme meetings using different channels and encourage their participation.
5. Organize meetings for women at places and time suitable for them.
6. Make it easy for women to hear and to be heard at meetings, by allowing them to sit together in the main gathering, and not behind, and by conducting meetings in the vernacular or arranging translation.
7. Stimulate dialogue by presentation techniques, inviting comments/questions/ criticism, and inserting discussion breaks for women and involving respected and representative spokeswomen.
8. If the women's participation in general, or poor women in particular, becomes difficult, then separate meetings at more convenient times and places need to be organized.
9. Explain the tasks and the authority involved in system maintenance, management, hygiene education, and system finance before choosing local candidates and discuss which roles will be best performed by women and who are the most suitable candidates.
10. Provide training adapted to women's conditions and roles, and include follow-up visits for monitoring and support.

Source. C van Wijk 1989.

and a women's group pays for the repairs. The voluntary agency that implemented the project has a cadre of women workers trained as pump caretakers based in about 40 villages. The agency also employs a mechanic to whom the women report serious problems that cannot be handled by them.

Where traditional funding is lacking, the women themselves make contributions in kind – of labour and possibly materials, particularly in small rural areas. Women contribute to savings in construction

costs both directly and indirectly. In Kenya, where women do much of the agricultural work, of 311 'self-help' projects, 41% of the contributors were women, and they contributed most of the labour, about 5000 hours in two water projects alone.

Employment of women

Women benefit directly from employment possibilities created by a water supply project. In India, for example, some 200 000 women were registered as labourers in the construction industry, which provides much of the workforce involved in digging wells, installing pumps, etc. (Sontheimer 1991).

Conclusion

W&S services are basic necessities of the community and are a precondition for development. However to achieve the objectives, it is essential to sustain the systems which are developed and also provide satisfaction to the consumers. Obviously, this cannot be accomplished without the support and involvement of the community for whom the services are created. Since women are the main caretakers of W&S facilities, their role and participation is critical for the sustenance of the facilities (Box 20).

Box 20
The SWACH project

Swach means 'clean' in Hindi. It is also an abbreviation for the Integrated Sanitation, Water, Guinea-worm Control and Community Health Project in Rajasthan, India. In this project, women are allowed to participate, and encouraged to come forward at all levels. Apart from being engaged as project staff members, rural women are also being trained as village animators, village contact drive members, and as handpump mechanics in-charge of the O&M of their own water sources. This is in spite of the traditional myths prevailing in the male-dominated Indian society as regards women's capabilities in general and in technical fields especially.

In the beginning, the emphasis was mainly on drilling wells and the development of handpumps, whereas, today the support also goes to other areas of importance such as fighting water-related diseases, giving children a better chance of survival, and involving women in the decision-making process. The importance to reach the rural women has been realized, as they bear the responsibility of fetching water, preparing meals, and seeing to the family's health and hygiene.

Contd....

Traditionally, the maintenance and repair of the pumps has been exclusively the work of men. During 1989, the project initiated an experiment, where 24 village women were trained to maintain and repair handpumps. Many of them are illiterate, but it is apparent that they are fully capable of the task. This represents a big step forward for women who had never before earned their own money. It is obviously of greater interest to women than to men that the pumps are in working order. Should the pumps break down, it is the women, who have to walk great distances to fetch water from dirty water sources.

The women are also involved in keeping daily contact with the other villagers. To this end, the project has recruited village women who have been given training in various relevant areas. They are called animators, or *sachetaks* in Hindi. 'The idea is that there should be one woman for every three to four villages, representing a population of 3000 to 4000 people,' says the project Director. 'Each woman should contact five to six households a day and talk to women about health and hygiene, the relation of water to health, on women's rights, etc. Furthermore, she is to see whether the handpumps are functioning, if not, she is to inform the handpump mechanic. She is also to check on how women go about fetching water and store it at home. In addition, they are to inform about any epidemics, especially those arising from water-borne diseases. Women are also being trained to pass on information to other remote villages.

With few opportunities existing for women in the rural areas, their income becomes an important addition to the household income.

The SWACH project is a good beginning and, if it continues to progress, the concept of integrating hygiene, health care, and health education into drinking water programmes can also spread to other parts of India. An important lesson is the effectiveness generated by working together with the people concerned, i.e., the villagers – especially the women and children. The SWACH project is fully supported by the Swedish International Development Authority (SIDA) channelled through UNICEF.

Source. Rodda 1994

Policy options, approaches, and future prospects

Introduction

Many environmental problems result from political and economic factors which are the basic determinants for policy matters. Intermittent or inadequate water supplies, for example, are rarely due to freshwater shortages; more often due to misguided priorities,

inappropriate pricing, or poor management. In the W&S sector, governments face a host of factors that hinder their ability to respond to problems. Consequently, full coverage remains a difficult goal everywhere as all regions must contend with rapidly growing populations. Globally, by the year 2000, the majority of the unserved (627 million, or 59% of the total) will reside in Asia and the Pacific. By that date, unserved populations will have increased over those of 1994 in both the African region, and the Latin American and Caribbean region. Most of the growth in the unserved will occur in rural areas in Africa and in the urban areas of Latin America.

Historic bias for water

To begin with, the historic 'bias' in favour of water (at the expense of sanitation and sewerage) is probably not only 'wrong', as is currently often implied, but actually right! The historical experience of industrial countries and the contemporary experience of DCs clearly demonstrate that only when the first challenge (the provision of services) has been substantially met do households and societies pay attention to the 'higher order' challenges of environmental protection. Thus it is not surprising, and not incorrect, that the portfolios of external assistance agencies have concentrated on the provision of water supply (The World Bank 1993 b). For example, of World Bank lending for W&S over the past 30 years, only about 15% has been for sanitation and sewerage, with most of this amount spent on sewage collection, and only a small fraction spent on treatment.

Fragmented management

Many governments face growing problems because they have failed to address issues related to safe W&S. Government activities are generally organized in a manner where W&S programmes are managed by a separate department or agency. Moreover within the water supply sector, the approach is fragmented – for example, irrigation, municipal water supply, power, and transportation – each is responsible for its own operations and independent of the others. The issues related to the quantity and quality of water, health, environmental and sanitation concerns are also considered separately, as are matters related to surface and groundwater. Problems of uncoordinated and fragmented decision result in a situation where programmes end up working at cross purposes with each other. As a result, some projects have deprived poor people, particularly the rural poor, of access to water of adequate quality and quantity to sustain them and their economic activities. This occurs when traditional riverine

communities do not participate in the planning and implementing projects and when their needs are not incorporated.

Population growth

Population growth and urbanization are the key factors underlying the enormous growth in the demand for W&S services. Under the most optimistic scenario, the world's population is expected to grow from 5.3 billion in 1990 to 6.2 billion by 2000, and to at least 8 billion by 2025. The growth in population, about 90% of which will occur in urban areas, will also increase the demand for water for domestic and industrial use and treatment of wastes. But the existing systems of W&S in many countries already fail to provide adequate services, and thus the problems posed by pollution are likely to grow. Urbanization and industrialization will also increase the demand for energy and hydro electric power. These developments pose a great difficulty for governments in the management and provision of water resources in the coming decades.

Institutional and political challenges

Countries guard their perceived water right notwithstanding the fact that many have not devoted funding to manage these surface and sub-surface water resources jointly. Data are not shared freely among nations, and cooperation is often lacking. As a result, water disputes over quantity allocations remain, and additional concerns are now arising over the effects that poor water quality and low flows have on aquatic ecosystems.

Priorities for action

Countries across the globe confront problems related to water supply and use. For many cities of the developing world, the top environmental priority remains improving access to clean water and sanitation. As the World Bank concluded in 1992, doing so would be the single most effective means of alleviating human distress. When services were improved in the developed countries in the nineteenth and twentieth centuries, health improved dramatically. In both the developing and the developed world, there is also a critical need to use water more efficiently, and intensify efforts to stop the deterioration of aquatic environments caused by municipal and industrial effluents.

Many innovative and effective approaches to management of W&S programmes are being undertaken around the world. Coping with the present problems will require sharing of responsibilities and involve action by a host of actors including national governments,

local government, NGOs, and communities particularly women, private sector international donors, and other external support. In the face of growing responsibilities and limited funds, it is necessary to make strategic choices about which problems to tackle first. Setting priorities by assessing the scale of impact and the cost and ease of solution is an important component of good management. Here again local groups – especially women – should be involved in identifying the key problems and their causes, and the capabilities of the communities to address these problems.

At the same time, attention must be given to cost-effective technologies, greater economic efficiency, and cost recovery. For instance, charging a nominal fee for W&S and supply can be a powerful incentive for water conservation. In addition, improving the maintenance and the efficiency of existing facilities can save money and reduce or delay large investments in new facilities. Finally, it is necessary to rely on a diverse range of policy tools from economic and regulatory instruments (to address specific problems such as water pollution) to broader planning strategies (such as community and women involvement).

Improving access to water and sanitation

Despite nearly US $100 billion in investments, the IDWSSD of the 1980s fell far short of meeting its goal of water and sanitation for all. But, it did bring into focus the magnitude of the health problems associated with inadequate W&S services and highlighted the need to find new strategies to improve coverage. Indeed, the programme's greatest achievement, by some counts, may have been the culmination of the decade.

Broadly, four key lessons emerged from the decade.

- Systems should respond to local demands and be as simple, sturdy, and inexpensive as possible
- The involvement of the community and households – particularly women – in system design and maintenance is a crucial component to a project's success
- Governments need to improve the efficiency and sustainability of system O&M.
- Water should be treated as an economic commodity paid for by user.

Despite a surprising degree of consensus on these points, many governments and donor agencies have yet to move beyond rhetoric to implementation, according to some critics. Translating the lessons into practice poses many challenges.

Developing sector strategies

To provide a framework for increased W&S investments, each country needs to have a comprehensive sector development strategy setting out overall objectives, priorities to be afforded to urban and rural areas, and the balance between W&S sub-sectors. It should include identification of responsibilities of all agencies active in the sector, and the role to be played by central and local government, private sector and NGOs, and benefiting communities. Clear definition is needed of the government's commitment to sector development; the resources to be allocated to it; policies for cost recovery, tariffs and subsidies; and the manner in which W&S sector planning is to be integrated with plans for urban and rural development, land use, water resources management, and environmental protection.

Within the overall sector strategy, governments can indicate the role to be played by external support agencies (ESAs). This may well include the provision of technical advice and support in preparation of the strategy itself; in strengthening the capacities of various actors involved through project components for institutional and human resources development; and the collection, analysis, and dissemination of appropriate technical information (ADB 1990).

Adopting appropriate technology and standards

The World Bank policy paper on water resources management gives a detailed account of the possible technology solution for the W&S sector. As stated in the document, 'the Decade made clear that the high-cost W&S systems adopted throughout the developed world – built and maintained by subsidized public agencies – will not work in the developing world.' The number of people unserved is far too great, and most government coffers are far too small to provide all residents with piped water and flush toilets in their houses. Whereas some parts of a city, such as the urban core, may be covered by conventional sewerage; other areas, particularly low-income settlements on the urban periphery, would be much better served by low-cost alternatives.

Evidence of the success of low-cost solutions can be found in countries around the world, from large-scale programmes for pour-flush latrines or ventilated improved pit latrines to community groups implementing small-bore sewer schemes. Each solution is unique, tailored to local conditions and needs, but most rely on the locally manufactured hardware (e.g., plumbing, sanitary sheds, or concrete caps for pit latrines) and the efforts of community members to install, maintain, and manage the systems. Systems using low-level standard technologies can be effective and less expensive, at only one-tenth to

one-twentieth of the cost of a conventional sewage system. Most of the low-cost systems require far less water, and once installed they can be upgraded gradually (Box 21).

One of the greatest barriers to installing low-cost alternatives is political opposition to what is considered 'low technology'. In many DCs there is still a tendency on the part of governments and funding agencies to insist on standards that are higher than necessary, sometimes doubling the cost of service delivery. In Cartagena, Colombia, for example, officials proposed a conventional sewage system even though a high water table existed and impermeable soils, and land levels well below the city sewer mains caused pipes to sink and necessitated pumping wastewater uphill to city sewer mains. Once local officials were persuaded that the lower standards of technology were not 'illegal', thus a system that uses a septic tank to remove biosolids and that which transports liquid wastes in small-diameter pipes was installed at one-third the cost of a conventional system. The system has been operating successfully for more than 10 years.

Condominial sewers have also proved to be a cost-effective alternative, and versions have been installed in low-income neighbourhoods in north-east Brazil, Pakistan, and Yemen. These sewers use a radically different layout, with smaller and shallower feeder sewers running from toilet to toilet of each house through each backyard. The waste water of an entire block discharges into the main trunk line at a single point rather than having to connect each house to the main trunk.

Box 21
Orangi Pilot Project

The Orangi Pilot Project in Karachi, Pakistan, illustrates the successes possible with low-cost sanitation alternatives. The community adopted a sewage system that filters biosolids into a tank, and therefore, uses smaller pipes and flatter gradients in the streets. The system costs one-tenth of the cost of installing conventional sewerage. Most of the funds were invested by the community; even now, the tanks and sewers are paid for and managed by groups of households. The municipality takes responsibility only for the construction and maintenance of the main trunk drains.

Source. The World Bank 1993 b.

Low-cost systems are not foolproof, however. Most rely on the active participation of community members in maintaining the pipes. While this reduces the utility's operating costs, the absence of community and organizational aspects results in poor performance of the technology (The World Bank 1993 a, b).

Involving the community

While selecting programmes and projects, the community's aspirations should be taken into account through well-designed feedback. In rural and low-income urban areas, the predominant role of governments and ESAs should shift emphasis from provision of services to promotion of community management, through increased access to information to enable communities to make informed choices. Programmatic approach should be used for project preparation and implementation, so as to provide flexibility and opportunity for community decision-making, resource mobilization, and capacity building to dictate the pace of development. More funds, time, and human resources should be allowed for promoting community management processes in the project preparation phase, and general community management processes should be the key aspect of project design during the early phases of project preparation.

By emphasizing the need for 'effective use' of W&S facilities, countries recognize that the dominant role of women in household hygiene has to be reflected in a corresponding involvement in planning and implementation of W&S programmes. Hygiene education and user awareness campaigns are proposed to stimulate effective demand for services, and these must be linked to the diminishing availability of fresh water resources and the corresponding need for protection and improved management of existing resources.

ESAs can help countries to promote greater awareness and implement community management approaches by: (i) collaborating with governments and NGOs in the financing of community-based projects; (ii) supporting private sector credit organizations and equipment suppliers, as partners in the process; (iii) adopting a programmatic approach to project preparation and implementation to allow community decision-making, resource mobilization, and capacity building to dictate the pace of development; (iv) including components for leadership development and training programmes and promotional campaigns within W&S programme support; and (v) encouraging and supporting regional exchange of experiences.

Community involvement in W&S projects is a key to their success (Box 22). Not only must communities be trained in O&M of the

systems, they also must be consulted to determine what type of system best suits local conditions. Women, the major users of a system, can provide valuable advice about the design and management of a W&S system. Failure to involve the community can lead to inefficient systems. In Nicaragua, for example, new latrines were not used by women because their feet when visible from outside, denying them the customary privacy. In contrast, when women are taught to maintain handpumps or otherwise manage collective water systems, they often perform better than men because they are less likely to migrate, more accustomed to voluntary work, and can be better trusted to administer funds. Involving communities has other benefits as well, such as greater community acceptance of a new system and correspondingly increased willingness to pay for a system and help maintain it (ADB 1990).

Box 22
Community initiatives

In Chinautla, an informal settlement in Guatemala city, Guatemala, community members asked the municipal water enterprise to install a single-source water tank, even though such units are typically used only temporarily. The community believed that this was the best solution to its water supply needs, and each family built its own pipe to the central source. The local community association receives one large bill from the water company, and one resident chosen by the community manages the billing and the collection of fees from each household. While the cost of the single-source water tank per family is more than those directly connected to the city's water supply network, it is still far less than what they had been paying for water from private vendors. (This system is being replicated in other settlements in Guatemala).

Source. The World Bank 1993 b.

Improving operation and maintenance

National and international agencies have placed far too much emphasis on the construction of new facilities at the expense of improving O&M of existing installations. In Mexico City, for example, 50% (7 out of 14) of waste water plants are operated at less than their designed flow capacity and treat only about 7% of the city's total waste water. The generally poor performance of public water and sewage utilities in DCs leaves ample room for improvement, and there is a major factor contributing to the high cost of these services.

In many cities, about half of the water that is treated and distributed at public expense is not accounted for. In Manila, the Philippines, for instance, 58% of water is unaccounted for, as opposed to 8% in Singapore. For Latin America as a whole, such water losses cost between US $1 billion and US $1.5 billion in foregone revenue each year. As much as one-half of the water not accounted for is due to unrecorded usage or illegal taps.

Box 23
Reducing water losses

In Caracas, Venezuela, approximately 30% of water connections are not registered. Reducing such losses is cheaper than reducing leakages, provided the utility has a sufficient number of trained staff. Major strategies include installing, promptly servicing, and recalibrating meters; updating and reviewing consumer records to estimate consumption when meters are unserviceable; and streamlining bureaucratic procedures to assist customers to make new legal connections.

Source. The World Bank 1993 a.

Reductions in unaccounted-for water can allow investments in new works to be deferred or at least reduced in scope, with significant savings. In addition, by improving the system of meter reading and billing or by detecting and charging for illegal connections, revenue can be greatly increased, which could be paid or also pay for water treatment and distribution O&M (Box 23). For example, in urban areas in Thailand in the 1980s, each 10% of unaccounted-for water saved was estimated to immediately generate an additional US $8 million per year from the 3.5 million people served.

Cost recovery

High priority is given to measures to make more effective use of available financial resources. Users themselves may have to bear a greater proportion of the cost, by tariff systems supported by effective metering, billing, and collection or, where these are inappropriate, through other alternatives. However, user charges need to be designed in accordance with each country's socio-economic conditions and resources situation. Increased efficiency of sector institutions can be achieved by: (i) setting up appropriate incentives for managerial improvement and efficiency; (ii) encouraging decentralization of

responsibilities to the appropriate extent; and (iii) developing effective human resources programmes.

Improved performance and O&M of existing systems is essential and rehabilitation of defective systems should be evaluated ahead of investment in new systems. Promoting adequate user charges creates incentives for service institutions. In urban areas of Asia, the private sector has great potential for W&S sector financing and management, and specific provision should be made for mobilizing and providing incentives for private sector involvement in W&S programmes in peri-urban areas.

In support of the country incentives to mobilize more funds and use existing funds more effectively, ESAs can provide immediate and regular assistance by: (i) assigning funds for capacity building, institutional and human resources development, and information exchange components in all new programmes; (ii) collaborating in the preparation and dissemination of materials which emphasize the benefits of the W&S sector to overall socio-economic development and environmental protection, and the methods available to optimize cost recovery and operational efficiency; and (iii) encouraging and facilitating the transfer of knowledge and experiences among the Asian and Pacific countries, through exchange of experts, workshops, and documented case studies.

With better cost recovery, utilities in the developing countries could improve the quality and availability of W&S facilities, potentially even in low-income areas. Water supply projects require huge capital investments, yet countries at times are faced with decreases in funds for W&S purposes and burgeoning urban populations. In DCs, consumers pay only about 35% of the costs of supplying water, according to a recent analysis of projects financed by the World Bank. Recovering a greater percentage of these costs could provide managers with funds to expand coverage in new areas or to maintain and improve existing facilities.

Drinking water, however, is a basic human need, and sufficient water for good hygiene is a prerequisite of public health. With these considerations in mind, governments have historically subsidized the cost of water. Unfortunately, these subsidies rarely reach the poor; instead, they most often benefit the better-off consumers with tap connections in these houses. In many cases, the poor are actually paying more than their wealthier counterparts for less reliable service. Water from vendors costs substantially more (and may be of poorer quality) than piped water in the same areas. Indeed, the poor may pay

as much as 30% of their income for water, while the well-to-do pay less than 2%.

Evidence exists that the poor are willing to pay for community as well as in-house water supply facilities of reasonable reliability. Unlike some other environmental amenities that benefit the public at large, it is the individual household that receives most benefits of piped water. The prevailing assumption is that households are willing to pay about three to five per cent of their income for access to clean water, yet actual studies reveal that some are willing to pay considerable more, some less.

The 1980s saw a widespread commitment to adopting more cost-recovery programmes, especially among donor organizations. Yet most urban and rural areas do not achieve full cost recovery in water supply operations, and equity concerns remain. There is no guarantee, for example, that a financially motivated utility will invest the additional funds in low-income neighbourhoods rather than high-income suburbs. Furthermore, the debate concerning how much to charge and to whom, and whether water supply tariffs should cover only O&M costs or should also generate resources for future investment is far from over (Serageldin 1994).

Promoting water conservation

For most countries, extending water supply coverage to current rural and urban residents is a challenge. Cities are also under pressure to expand their municipal water supplies; it is predicted that the demand for municipal water could grow by a factor of five or more over the next four decades. Many cities already face critical water shortages and high costs of supply. The usual response is to increase supplies through expensive investments in new public infrastructure. Yet evidence suggests that countries can also manage the demand for water by reducing wastage (through pricing and conservation efforts) and by preventing pollution. A comprehensive strategy would include improving the O&M of water supply systems, removing subsidies and price distortions that encourage waste, and educating the public. Demand management is a particularly attractive option for cities in the developed world, where per capita water consumption is many times to that of the developing world. Recycling, especially of industrial waste water, is another attractive strategy, providing companies with a cost-effective and reliable source of water, and at the same time protecting the environment (Box 24).

Box 24
Reducing losses

In Boston, impending costs of supplying water to the city led officials to implement a Long Range Water Supply Program (LRWSP) to cut down on water use. Between 1988 and 1993, LRWSP reduced the average daily demand for water from 1.2 to 0.9 million cu.m in the city. The programme focused on detecting and repairing leaks, metering, retrofitting showerheads and toilets with more efficient technologies, protecting water sources from pollution, and building support for the programme among city residents through outreach and education. These reductions eliminated the need to develop new supplies, saving hundreds of millions of dollars, and the water system is operating within its safe yield for the first time in 20 years.

Source. The World Bank 1993 b.

In DCs, several cities have been implementing demand management programmes. In Mexico City, for instance, the water utility implemented a new rate structure that charges more per cubic metre as consumption levels increase. It is hoped that this measure will provide metered industries with incentives to conserve water. In Sao Paulo, Brazil, the imposition of effluent charges induced reductions in water demand between 42% and 62% in three industrial plants (Box 25).

Box 25
Reducing industrial water consumption

A study in Beijing showed that a combination of strategies could reduce industrial water consumption by about one-third, at a cost substantially less than that of investing in new supplies. The measures included increased recycling of cooling water in manufacturing; recycling of cooling water in power plants; and waste water recycling. Similarly, about 15% of domestic consumption could be saved through measures such as improved efficiency in public facilities, establishing a leakage reduction programme, recycling of cooling water used in air conditioning, and installation of water-efficient flush toilets.

Source. The World Bank 1993 b.

Reducing water pollution

By reducing water pollution, cities can reap the twin benefits of effectively increasing water supply while lessening the deterioration of the aquatic environment. As the 'pollution shadow' spreads, cities must go further afield to find clean water, which significantly increases the costs of water supply. Shanghai, China, for instance, moved its water intake 40 km upstream at a cost of US $300 million because of the degradation of river water quality around the city.

Of all the pollutants, urban sewage may be the worst offender in near-urban waters, although industrial pollutants can be a major source. In addition, up to half of the contaminants reaching urban waters come from non-point sources, such as urban run-off. Controlling urban runoff, although difficult, is essential if cities are to mitigate their impacts on nearby water bodies.

Preventing pollution in the first place may be the best long-term solution. One study in Santiago, Chile, found that although full waste-water treatment would cost about US $78 million annually, the economic and health benefits resulting from pollution prevention could justify this investment.

Future prospects

An estimated 2.9 billion people lack access to adequate sanitation, up from 2.6 billion in 1990. But access to safe water is improving. Today, almost 800 million more people can count on safe water supplies than in 1990. The number with access to safe water increased from 2.5 billion to 3.3 billion.

Most governments and communities have placed a higher priority on safe water, but that in itself is not a panacea for all ills. Without a stronger commitment to sanitation, it will be difficult to reduce the incidence of diarrhoea, which is a leading child killer, and other diseases that flourish in unsanitary conditions. Among steps to combat disease and malnutrition, the Convention on the Rights of the Child calls on countries to ensure provision of clean drinking water and sanitation (Article 24).

Table 13 shows the percentage of people with access to safe drinking water and sanitation in the 15 DCs with the largest under-five populations, along with the percentage point gap between the two. In Bangladesh, China, Egypt and India, the gap is greater than 40 percentage points, with Egypt, having the widest – 54 percentage points. Only in Nigeria is the gap reversed, with 58% of the population having access to sanitation and 51% access to safe drinking

water. A small gap is not necessarily a sign of success. Ethiopia, for example, has a small gap, but also has the lowest combined access rate among these countries: 25% for safe water and 19% for sanitation.

Table 13
Coverage gaps in developing countries with the highest under-five population

Country	Access to safe water(%)	Access to sanitation(%)	Point gap (%)
Egypt	83	29	54
India	81	29	52
Bangladesh	97	48	49
China	67	24	43
Brazil	72	44	28
Pakistan	74	47	27
Congo, D. Rep.	42	18	24
Vietnam	43	22	21
Myanmar	60	43	17
Mexico	83	72	11
Iran	90	81	9
The Philippines	86	77	9
Indonesia	61	53	8
Ethiopia	25	19	6
Nigeria	51	58	-7

Data from 1993 to 1995, except Brazil and Ethiopia (1991).
Sources. WHO 1996 b.

Water supply

The Water Supply and Sanitation Sector Monitoring Report (WSSSMR), December 1994 gives a detailed analysis of the future W&S scenario. Between 1990 and 1994, the population of DCs rose by 312 million to 4383 million. In the same period, based on the data reported through the Joint Monitoring Programme and extrapolated for non-reporting countries, a total of 781 million people gained access to safe water. The total number of people still lacking access therefore reduced by 469 million. That still left a total of 1115 million people unserved in 1994, i.e., about 25% of the population of DCs.

With an average of 195 million people gaining access to safe water every year (over half a million people every day), the number of

people served was growing, approaching eight per cent per year which is a marked acceleration over the rate of progress achieved during the 1980s. These figures need to be treated with some caution, particularly as there have been substantial differences in the coverage increase in different regions and between urban progress to that in rural areas.

Despite the apparent overall achievements, the available data indicate some alarming trends. The improvement in water supply coverage occurred overwhelmingly in Asia and the Pacific where about 700 million people have been served in for four years. Indeed, the Asia and Pacific countries account for nearly 90% of the progress achieved in water supply and for 95% of the rise in rural water supply. The rise in water supply achieved in other regions are far more modest. In Africa, 38 million people gained access, while in Latin America and the Caribbean, extra 30 million people were served, representing respectively five per cent and four per cent of the total number who gained access to safe water during the period.

The figures show that the greatest water supply progress from 1990 to 1994 was in rural areas. The 611 million extra rural people served during the four years raised rural water supply coverage from 50% to 60%. In urban areas, the extra 170 million people served was offset by a 205 million increase in the urban population, leaving the percentage coverage unchanged at 82%. Clearly the effects of high population growth and accelerating urbanization are proving a formidable challenge.

Sanitation

Analysis of the global sanitation figures gives the unavoidable impression that sanitation has been almost totally neglected from 1990 to 1994. While the application of tighter definitions as to what constitutes 'adequate' sanitation has evidently had some impact (the number of rural people deemed to be adequately served actually fell by 31 million), the comparison with water supply progress makes it clear that investment in sanitation improvements remains a low priority for many governments and communities.

Overall, the number of people deemed to be lacking in adequate sanitation rose by 274 million in the four years (1990–94), with percentage coverage falling in both urban and rural areas. At the end of 1994, a mere 18% of rural people had access to adequate sanitation services, leaving some 2284 million rural dwellers unserved. A further 589 million urban residents also lack proper sanitation, which is about 146 million more than in 1990. Only Western Asia bucked the trend of

decreasing coverage, and even there, the population not served with sanitation facilities rose by a million during 1990–94.

Conclusion

The direct effects of improved W&S services on health are most clearly seen in the case of water-related diseases, which arise from the ingestion of pathogens, contaminated water or food, and from exposure to insects or other vectors associated with water. Esrey et al. (1991) (Table 14) calculated that access to sustainable safe drinking water and sanitation services for populations currently at risk would result in:

- 200 million fewer diarrhoeal episodes,
- 2.1 million fewer deaths caused by diarrhoea,
- 76 000 fewer dracunculiasis cases,
- 150 million fewer schistosomiasis cases, and
- 75 million fewer trachoma cases.

Table 14
Effects of improved water and sanitation on sickness

Disease	Millions affected by illness	Median reduction attributable to improvement (%)
Diarrhoea	900[a]	22
Roundworm	900	28
Guinea-worm	4	76
Schistosomiasis	200	73

[a] refers to number of episodes in a year
Source. World Bank 1992.

The following case studies give a brief account of W&S on health aspects and the improvement in quality of life when there is better access to W&S facilities (Boxes 26, 27, 28).

The positive impact of improved water quality is greatest for families living under good sanitary conditions, with the effect statistically significant when sanitation is measured at the community level and not significant when sanitation is measured at the household level. Improving drinking water quality would have no effect on

Box 26
Health impact

Case I. A health impact evaluation of the Rural Sanitation Pilot Project in Mohale's Hock district, Lesotho, was conducted from October 1987 to September 1988. A clinic-based case-control design was used to investigate the impact of improved sanitation on diarrhoea morbidity in young children. The study revealed that under-five-year-old from households with a latrine may experience 24% fewer episodes of diarrhoea than such children from households without a latrine (OR = 0.76; 95% confidence interval, 0.58–1.01). The impact of latrines on diarrhoea was greater in those households that used more water, practised better personal hygiene, and where the mothers had a higher level of education or worked outside the home. In common with studies conducted in Malawi, The Philippines, and Sri Lanka, little evidence was found that the relationship between latrine ownership and diarrhoea was confounded by socio-economic status or environmental variables. For a sample of cases and controls, data on exposure status (presence or absence of a latrine) collected by interview at the clinics agreed closely with those obtained by observation during a home visit.

Source. Daniels , Cousens, Makoae , Feachem.

Box 27
Health Impact

Case II. The impact of a water, sanitation, and hygiene education intervention project on diarrhoeal morbidity in children under five was evaluated in a rural area, in Bangladesh. Data was collected throughout 1984–1987, covering both pre- and post-intervention periods, from an intervention and a control area. The two areas were similar in most socio-economic characteristics and baseline levels of diarrhoeal morbidity. The project showed a striking impact on the incidence of all cases of diarrhoea, including dysentery and persistent diarrhoea. By the end of the study period, children in the intervention area were experiencing 25% fewer episodes of diarrhoea than those in the control area. This impact was evident throughout the year, and particularly in the monsoon season, and in all age groups except those less than six months old. Within the intervention area, children from households living close to hand pumps or where better sanitation habits were practised experienced lower rates of diarrhoea. These results suggest that an integrated approach to environmental interventions can have a significant impact on diarrhoeal morbidity.

Source. Aziz et al.

Box 28
Schistosomiasis control

Case III. Despite the success of control programmes, schistosomiasis is still a serious public health hazard in the world. More than 70 countries, where 200 million individuals are estimated to be at the risk of infection of a total 600 million. Though there have been important local success in the control of transmission; globally, the infection has increased. Economic constraints in developing countries, environmental changes associated with migration, and water resources development have been blocking the progress. The main objective of schistosomiasis control is to achieve the reduction of the disease. We discussed the control measures like health education, diagnosis and chemotherapy, safe water supplies, sanitation, and snail control. We emphasized the need to give priority to school-age children and the importance of integrating measures of control into the locally available systems of health care. The control of schistosomiasis is directly related to the capacity of the preventive health services of an endemic country. The control strategy requires long-term commitment from the international to the local level.

Source. Dias, Marcal, Glasser 1995.

neighbourhoods with very poor environmental sanitation. Improvements in W&S is necessary if health standards in DCs are to be improved. Moreover, it is not only epidemiologic but behavioural, institutional, and economic factors that should correctly determine the priority of interventions.

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Nutrition

The realization of the importance of women's health and nutrition in developing countries has grown over time. The growing recognition of women's value in social reproduction emphasizes that, not only do they have special nutrition and health needs and problems during pregnancy and childbirth, but they also customarily have problems in providing care and nutrition for their family members including children. This, indeed, is a shift from the traditional concept of maternal and child health to a view of women's existence in the wider realities of their social roles and activities. In other words, the issue of women's health and nutrition is no longer restricted to the narrow concept of childbearing, rather it involves every phase of women's life cycle (Winikoff 1988), including shaping the health and nutrition of their newborns.

The lives of women differ from those of men, both biologically and socially. This places them at a greater risk of nutritional deficiency. The importance of their nutritional status to their own health and productivity, and to the survival and health of their children and other family members depends largely on the status that

women are offered in the family and at social levels including domestic and market work (Leslie 1991).

Women in developing countries

Developing nations are at a disadvantage in the global economy. The per capita gross national product (GNP) of low-income economies, including China and India, varies between US $60 (Mozambique) and US $670 (Indonesia), and increases steadily with the rise in the national level of economy (World Bank 1994). For the middle-income economies, it is between US $670 (Cote d'Ivoire) and US $7510 (Saudi Arabia). Whereas for the high-income economies, it ranges from US $12 210 (Ireland) to US $36 080 (Switzerland) (World Bank 1994). In the poor economies, inadequate basic infrastructure and low priority given to expenditure on health, education, and welfare have implications for the health and nutrition of the people including women. Further, sociocultural factors relating to the status of women in society, regional differences in living conditions, and experiences of epidemiological transition in disease patterns are also important in determining the nutrition of women in developing countries (DCs) (Walker 1997).

Despite marked improvement in primary and secondary education (females/100 males) in the low-income countries between 1970 and 1992, women are far behind men in labour force participation. During this period, low and middle economies have experienced a decrease in the proportion of female labour force participation in various degrees, while the high-income countries have experienced an overall increase. Moreover, the decrease is much higher among the low-income economies compared to the middle economies (World Bank 1994: 218–219). While labour force participation of women in DCs evidences such a sorry state of affairs, the labour that they produce in the domestic domain, is often kept out of the official male-dominated definition of women's work (Kalpagam 1993). Similarly, women's deprivation of nutritional and health care and its consequences for their children are clearly reflected in the prevalence of low birth weight (LBW) babies, which swells up as the income of these countries declines (World Bank 1994).

Women suffer from discrimination and deprivation in various other aspects of their lives as well. Sex ratio, an important indicator of women's social status reveals their disadvantageous position in the

developing parts of the world, in contrast to the developed regions (UN 1995). While in the developed regions, nearly 96% countries have a sex ratio in favour of women, the proportion steadily declines in the African (82%) and Latin American and Caribbean (67%) countries, followed by Asia and the Pacific (42%) and Oceania (6%) regions (Table 1). Further, while most parts of the developed world have more women than men in urban areas, the developing regions continue to have higher proportion of women to men in rural areas (Figure 1).

Table 1

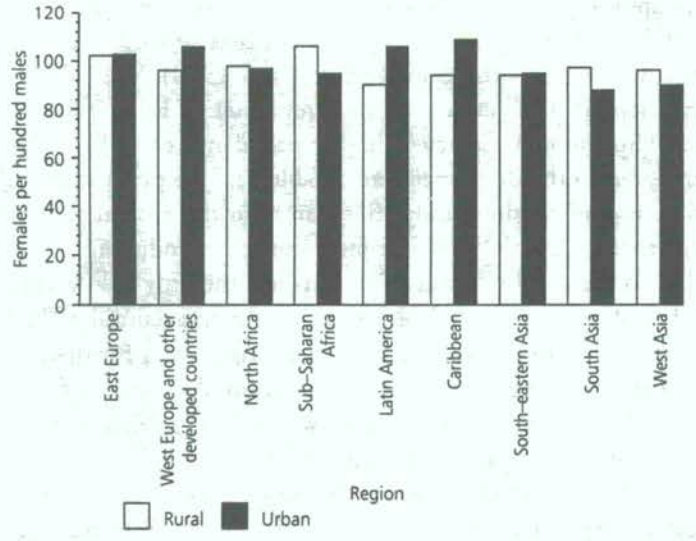
Females per hundred males in developed and developing countries, 1995

Region	Countries	< 100		> 100	
		number	per cent	number	per cent
Developed regions	49	02	4.08	47	95.92
Africa	55	10	18.18	45	81.82
Latin America and Caribbean	39	13	33.33	26	66.67
Asia and Pacific	48	28	58.33	20	41.67
Oceania	17	16	94.12	01	5.88

Source. UN 1995.

Figure 1

Sex ratio in urban and rural areas, 1995



Source. UN 1995.

Given the poor social status conferred on women in DCs, the state of their nutrition is largely manifested in the form of macro and micro nutrient deficiencies (WHO 1994).

The state of women's nutrition

Protein energy malnutrition (PEM), iron deficiency anaemia, iodine deficiency disorders (IDDs), and vitamin A deficiency are the major nutritional deficiency disorders of concern in the developing world. While all of them show gender differentials in prevalence and severity, the prevalence of PEM is significantly higher among women in South Asia (WHO 1994). Both iron deficiency anaemia and iodine deficiency–goitre are more prevalent among adult women than men, though vitamin A deficiency appears to be more prevalent among boys than girls. The conservative estimates of the World Health Organization (WHO) suggest a sorry state of affairs. In 1985, more than 44% of the total estimated 1130 million adult women living in DCs were anaemic (iron deficiency). Almost a similar proportion had stunted growth as a result of childhood PEM, about 22% of the women were at risk of severe IDDS, nearly 10% suffered from goitre, and around 0.17% were blind due to vitamin A deficiency (WHO 1994: 35). Thus the poor social status of women in the DCs reflects on their poor nutritional status.

Women's deprivation of nutrition and health care has consequences upon their children as well. The picture of women's nutrition at and during pregnancy reflects on the prevalence of LBW babies and this varies across the globe (World Bank 1994). With the decline in the income of the countries, the prevalence of LBW babies also increases. Thus, most DCs have a higher prevalence of LBW babies as compared to the developed ones (Table 2). The prevalence of undernutrition among children under-five also follows a similar trend. Although maternal malnutrition is a prime factor in introducing undernutrition to the children under-five, it is not the only risk factor.

The burden of nutritional deficiencies that women accumulate in the early stages of their lives also acts as a critical risk factor for their health and nutrition during pregnancy and lactation. A number of microstudies in the Indian subcontinent show that girl children are breastfed lesser, get poorer quality of food, and are less likely to be taken to hospital if sick (John, Lalita 1995), all of which have either direct or indirect implications for their health. In a cross-sectional

Table 2

State of nutrition amongst women and children in some developing countries (%)

	LBW	Prevalence of malnutrition (in children under five years)
Low-income economies		
Tanzania	14	25.2
Bangladesh	50	66.5
India	33	63.0
Kenya	16	18.0
Nigeria	15	35.7
Pakistan	25	40.4
China	9	21.3
Sri Lanka	25	36.6
Indonesia	14	39.9
Middle-income economies		
The Philippines	15	33.5
Guatemala	14	28.5
Jamaica	11	7.2
Thailand	13	13.0
Brazil	11	7.1
Botswana	8	15.0
Mexico	12	13.9
High-income economies		
Australia	6	7.0
United Kingdom	7	7.0
Italy	5	8.0
France	5	7.0
Canada	6	7.0
United States	7	9.0
Denmark	6	7.0
Sweden	5	5.0
Japan	6	5.0

Source. World Bank 1994

study, Chaturvedi and co-workers (1994) revealed that the diets of 941 adolescent girls from poor socio-economic groups in rural India were deficient in energy and protein up to 36% and 32%, respectively. Prevalence of vitamin B-complex deficiency and anaemia was even higher (44% and 73%, respectively). National level surveys conducted in India and Pakistan reported calorie inadequacies among

41% and 60% of the adult population respectively, against the recommended daily allowances (Chatterjee, Lambert 1989). Though these surveys did not reveal a clear or consistent evidence of gender differences against adult women, Stanton and others (1986) pointed out that male gender acted independent of prevalence of vitamin A deficiency in Bangladesh. Similarly, while population surveys conducted in Papua New Guinea, Kenya, Ethiopia, Brazil, and Guatemala during 1980–1990 revealed that protein intake is usually more than adequate, possibilities of women consuming lower quality of protein than men has been strengthened by studies elsewhere (Walker 1997).

China, however, represents a different picture. A study indicated that the nutritional status of urban Beijing residents improved with the increase in food production and better sanitation facilities since 1949. Though the residents met the recommended dietary allowance and their nutritional status was satisfactory, the intake of micronutrients such as riboflavin, zinc, and calcium was inadequate in the adults and the elderly. Similarly, zinc and iron deficiency anaemia were common in children (Zhao 1992). Though the studies which reveal specific micronutrient deficiencies in the study population lack in gender comparisons, attempts in the developed countries have been successful in doing so. For instance, Biro and co-workers (1996) in their study revealed higher risks of calcium deficiency in adolescent girls compared to their male counterparts (85% and 43%, respectively). Also, Dawson-Hughes (1996) pointed out that increased rates of bone loss in post-menopausal women are likely to lead to calcium and vitamin D deficiencies.

Apart from the lack of nutrients in the diet and inferior nutritional status, people in the DCs are also exposed to contaminated water and food. Contaminants such as various chemicals including organic pesticide residues or other toxins have possible implications for nutritional status. However, there are indications that specific living conditions in the domestic domain expose women to higher risks as compared to men. But lack of reliable data makes it difficult to draw any direct conclusion, even for the population in general (Baht, Moy 1997).

The domestic environment

The domestic environment that women in the Third World occupy creates a burden on their health. While roughly two-thirds of the world population are among the poorest, women constitute the

majority of the poor. To ensure the survival of the family they carry a tremendous burden of work. Time budget studies show that women not only perform physically heavier work to fulfil their social roles; they also work longer hours than men. Women are responsible for growing food crops, collecting water, gathering fuel, and performing most other work which sustains the family. In Malwai, Africa as many as 90% of the women are involved in cultivating food. Studies in Africa have shown that carrying water can use 12% of the calorie intake of women in the plains, and up to 27% in dry and steeper areas. They also reveal that collecting water can take very long and each load can weigh as much as 25 kilograms (Dankelman, Davidson 1988).

For household energy supplies, the rural areas depend mainly on biomass such as fuelwood, crop residues, and dung. 75% of rural energy supplies (90% in Africa) come from biomass. Fuel collection, where it is not commercialized, is mainly a task for women, with children's help. Depending on the ecological characteristics of the area they live in, women may spend up to five hours a day in fuel collection. Activities in the home, like food preparation and taking care of family, are the exclusive responsibility of women. These involve both time and energy. In Peru, women spend an average of four hours in cooking. Yet, women in many cultures are often the last to eat and consume less than the other family members (Dankelman, Davidson 1988).

In DCs, women contribute substantially to the family budget through income-generating activities, particularly in the female-headed households. The proportion of such households is increasing in all regions (UN 1995). In spite of the labour and income contributions of women to the farming households, men appear to have predominant control over decision-making (FAO 1995). Notwithstanding their important role, women have only very limited access to, and control over, productive resources like income, credit, land, education, training, and information. This has also been the focus of organizations like Food and Agricultural Organization (1995), which in its study conducted in the rural areas of 17 near east countries revealed various aspects of the burdens of the environment on women.

This and other evidence confirms the existence of gender bias against women in the domestic domain. The discrimination prevails not only in the division of labour, or in access to economic resources, food, and services such as health care and education, but also in preference for sons than daughters and socialization (Harris 1995; Thomas 1990; Aziz 1989; Lily 1989; Chen, Huq, D'souza 1981). Moreover, specific occupational and living environment of women exposes them to various kinds of biological and social hazards (Okoji

1994), including exposure to contaminated water, food, and indoor air pollution.

Domestic environment vis-à-vis women's nutrition: forces and processes

Attempts have been made to understand the relationship between health and environment within a gender-sensitive perspective. The causes and effects of the generally poor nutritional status of many women in DCs have been identified and analysed (WHO 1994, 1997). The relationship between the domestic environment in these countries and nutrition of their women and children is a complex phenomenon. While nutritional deficiency of women is an effect of the exposure to various risk factors emerging in the domestic environment, this also acts as a major driving force in transferring undernutrition to their children.

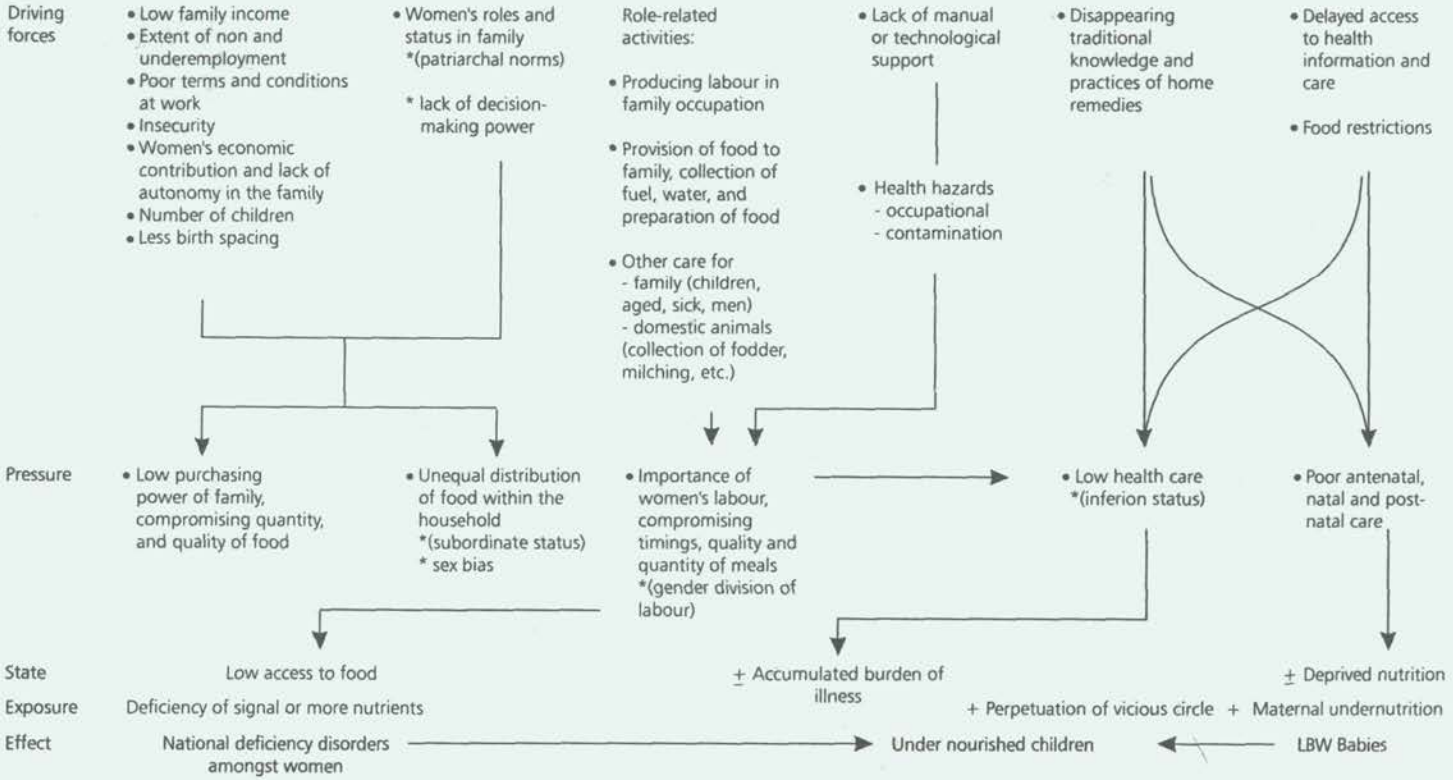
There are certain major forces within the household which, either individually or in complex relationships with others, act as driving forces and create varying amounts of pressure on women throughout their life cycles. Thus, certain living conditions are created which expose women to various risks that initiate or accelerate nutritional deficiency. This, in turn, increases the risk of intra-uterine undernutrition (foetal) for the future generation. However, the driving forces prevailing in the domestic environment are also constantly influenced by the forces located in the environment outside.

The commonly understood driving forces are rooted in the economic and non-economic arena of the domestic environment. The forces which originate in the economic basis of the household are low family income, employment status, terms and conditions at work, criticality of women's income and lack of control over it, poor access to maternal and general health care services, and information and education. Similarly in the socio-cultural context of family, women's roles and status, their work within the house, lack of human or technological support network, and the disappearance of traditional knowledge and practices to keep up health and nutrition are the major forces (Figure 2).

In the families of transitional developing societies, women are faced with the challenge of combining their income-generating role

Figure 2

Women's nutrition and domestic environment: forces and processes



Note: *Gender issues

and the roles of food provider, caretaker, and free labour producer in family occupation. The hold of patriarchal norms, however, continues to prevail at the family level determining women's status and attitudes of the family towards them in different phases of life. Above all, while poverty, poor drinking water supply, housing, and sanitation in association with lack of women's power and participation in decision-making at the domestic level may contribute to undernutrition, in turn, may also be the cause of exposure to illness (WHO 1994, 1997). Murray and Lopez (1996) have identified undernutrition as a major risk factor contributing to the greatest burden of illness.

Poor access to food

The trend in food consumption and nutritional status in DCs, over the past two decades, shows that greater household food security (as measured by adequate calorie) through raising income and food availability is an important factor in ensuring nutrition within the household.

However, it also shows that increased food security does not necessarily reduce malnutrition as the access to non-food inputs such as health care services, education, sanitation, and clean water may be denied (Haddad, Bhattarai, Immink 1995). Referring to a study conducted in eight DCs, it is also pointed out that whether increased food security would improve nutritional status of a social group varies greatly by the location and markets for non-food goods and services. Although access to food is a basic determinant of good nutrition, repeated exposure to illness is detrimental to nutritional status. When the incidence of illness is high and household food security low, the cost of nutritional status is great. The synergy between food consumption and illness is more pronounced when access to food and non-food services is poor.

Within the household, though female headship is yet to be significantly related to nutritional intake or status of children, its positive impact on child nutrition has already been exposed in Kenya (Onyango, Tucker, Elsenon 1994). While women contribute positively to nutrition of children, women in poor households work harder than men but eat lesser. Given the high costs of poor women's combined productive and reproductive roles, the impact of heavy workload and insufficient nutrition on their health is substantial. Increased workload of women affects the health and nutrition of pre-school children, depending on the socio-economic status of the family, number of children at home, birth space with the next and elder child, and

availability of male substitute care within the household (Devin, Erikson 1996).

Though women's employment is critical for the food security of the household, especially in low-income families (Haddad 1992), it is their nutrition that is compromised the most in coping mechanisms adopted by the family. Economic scarcity of the family lowers its purchasing capacity while the food basket and the quantity and quality of meals may be adjusted for the whole family. However, it affects the women most, as they are given subordinate status in the family and are supposed to eat last, and most consequently the least. Women's lesser access to food in the family is a phenomenon that is evident from childhood, in the practice of sex bias at the family level. In adverse circumstances of food scarcity, it has always been women who adjust their lives to absorb the brunt of the burden. This usually means that they have to work longer hours just to keep their family afloat. This invisible adjustment jeopardizes women's health as well as that of their children in DCs (UN 1991).

Importance of women's labour

Putting labour into family occupations such as agriculture or industry and providing food to its members, caring for the men, looking after children, the aged and the sick, and taking care of domestic animals are some of the household activities performed by women.

Provision of food for the family involves collection of fuel and drinking water and preparation of food. In the developing societies where a larger proportion of the population still lives in the villages, women have to travel long distances for long duration to collect fuel and water. These activities increase the energy expenditure which has to be met through daily nutrition. Moreover, preparation of meals in the kitchen, which is supported with little technological gadgets/ advancements, makes it more laborious, time-consuming, and also hazardous. Manual help from men is limited as it is against the patriarchal norms of the family. The support network within the family has reduced due to changing occupations of other members of the family. Besides working at home, some women may also work in household industries. As a consequence, they compromise on timings, quality and quantity or frequency of meals leading to malnutrition. The additional needs, specially during pregnancy and lactation, make their situation even worse.

The heavy workload of low-income women in the DCs is related to energy expenditure (Leslie 1988; McGuire, Popkin 1990).

Compilation of time allocation studies from different regions reveals that rural women from Nepal, Burkina Faso, and Nicaragua spend 7 to 12 hours in household agriculture production, food preparation, fuel and water collection, and crafts and marketing in household industries (Table 3). The time spent on childcare, however, is difficult to measure. On an average women work longer hours than men and have lesser time for leisure (Walker 1997).

Studies report that the time spent in various household activities and energy expenditure of women is still a less-researched area. Energy costs of various activities are generally calculated on the basis of intensity of tasks, using standard values for the energy cost of activities (WHO 1985). A retrospective assessment by Walker (1997) reveals that besides the time spent and the intensity of activity, energy costs of women's activities varies across seasons and phases of pregnancy. The lower level of the range is calculated as 7.9 MJ for rural Ethiopian women while the highest is observed among the farming women in Burkina Faso during the rainy season (12.1 MJ). However, it went down to 9.7 MJ during the dry season. In a study among rural Beninese women, Schultnik and co-workers (1993) have clearly indicated the influence of harvesting pattern on nutritional coping of women with food scarcity. They commented that during such scarcity arising during pre-harvest season, women showed some metabolic adaptation that prevented loss of body weight and did not show significant seasonal changes in physical activity level. According to Walker, most research on energy expenditure in Third World women

Table 3
Time allocation (hours/day) of women in developing countries from three regions

Activities	Nepal	Burkina Faso	Nicaragua
Agriculture	3.7	4.6	—
Collecting food and water	1.1	0.7	0.5
Food processing and cooking	3.0	2.0	3.5
Childcare (often with other tasks and not recorded separately so may be underestimated)	0.7	0.1	1.0
Other work (including household activities, crafts, and marketing)	2.3	2.1	5.6
Total	10.8	9.5	10.6

Source. Walker 1997.

has focused on energy costs of pregnancy and lactation. More information needs to be generated on the energy expenditure of non-pregnant non-lactating women in developing countries.

The economic burdens of the family, along with increased demand on women's physical labour and time, also exposes them to various risks in the domestic and occupational environment, affecting their health and nutrition. Thus, women's social roles and status have emerged as forces associated with their nutrition. Similarly, the strong possibilities of the adverse impact of various chemical pollutants on women's health and nutrition, through the environment they are more closely interacting with as compared to their men, cannot be ruled out (Baht, Moy 1997). In turn, breastfed infants are likely to be affected, too.

Moreover, while working in family agriculture or household industries, women are affected by occupational hazards that involve bad posture, damage to eyesight, exposure to dust and toxic materials, gynaecological disorders and mental stress, anxiety, and depression (John, Lalita 1995; Chatterjee 1993). Some of these health problems of women relate to their food intake and nutrition. Similarly, expanded cash-cropping not only reduces local food availability but also increases workload on women involving additional energy expenditure. Rural women's energy expenditure is often higher than their food intake especially during pre-harvest crisis. All these influence the physical and metabolic processes involving nutrition.

Besides, social sex discrimination against female children, emphasis on women's childbearing roles and their workloads interface with their subordinate status in health care. This exposes women to health hazards including nutritional deficiency. Moreover, lack of autonomy relates to poor nutritional status of women by oppressing their decision-making power and access to independent income. Marriage at an early age is yet another factor that puts them at risk of undernutrition and exposes them to health hazards.

Inadequate maternal care

The rates of maternal mortality range between 40 and 1100 per 100 000 births in sub-Saharan Africa, South Asia, Latin America and the Caribbean countries. In contrast, it is even less than 20 per 100 000 births in Europe. This difference can be explained by inadequacies in maternal nutrition and health care increasing the risk of complications at birth and of mortality (Walker 1997).

Women's nutritional requirements increase during pregnancy and lactation. A case control study in Indian women has estimated the

energy cost of pregnancy as 30–171 MJ (Pier, Diggavi, Thangam et al. 1995). The study revealed that the total estimated cost of pregnancy is met by the cumulative increase in energy intake over the last two trimesters of pregnancy. Extra energy required during lactation is met largely by increase in energy intake rather than by any metabolic economy or increase in fat metabolism. But in situations of already existing nutritional deprivation in women, maternity creates further demands on their reserve. Popkin and others (1993) had earlier examined the roles of Filipino women's nutrition and infant feeding on the duration of post-partum amenorrhoea. Low body mass index (BMI) and low dietary fat were found to be associated with increased duration of post-partum amenorrhoea. Simultaneously, Prentice and co-workers (1993) studied intake of calcium and phosphorous by 148 pregnant and lactating rural women in the Gambia. The study revealed that there was no difference in calcium intake between pregnant and lactating women but phosphorus intake in lactation was 11% higher than that in pregnancy during post-harvest season. Similarly, both iron deficiency anaemia and IDDs have also been linked to the reproductive biology of women, besides low intake and poor absorption of respective minerals. Anaemia has also been associated with malaria and hookworm infections (Chatterjee 1989).

Given the lack of ability to take decisions within the household, most women in DCs bear additional pressure of reproduction. On the basis of estimation of McGuire and Popkin (1990) among women in Costa-Rica, Bangladesh, Asia, and Africa, Walker (1997) pointed out that the average number of births in women in DCs range from four to eight. When the amount of time spent in breast-feeding is added to this, a large proportion of the Third World women's reproductive years are spent under the increased nutritional demands of either pregnancy or lactation. Moreover, frequent reproductive cycles, particularly among women whose nutritional intakes are marginal, are likely to contribute to the deterioration in maternal nutritional status. Studies among the non-pregnant non-lactating women in Bangladesh have shown this (Huffman, Wolff, Lowell 1985). In other studies, approximately 50% of women in Guatemala and the Philippines experienced overlap of lactation with subsequent pregnancy (Merchant, Martorell, Haas 1990; Siega-Riz, Adair 1993). The intra-household dynamics in the developing societies often critically determine women's reproductive decision-making (Adams, Castle 1994).

Poor access to general health care

Adequate food intake alone does not ensure nutritional status. Illness episodes, severity and duration of illness, treatment received, and care during and after the illness episode – all these exercise an interrelated effect on women's nutrition profile. Because of undernourishment, recovery from illness becomes a longer process.

Despite the prevailing higher levels of morbidity and undernutrition among women, they receive less health care than men do. Gender discrimination in food allocation and health care go hand in hand and tend to reinforce each other. Women's use of health care services is determined by (i) the need, i.e., the extent of ill health among women; (ii) permission, i.e., social factors that condition women's chances of seeking health care outside the home; (iii) ability, i.e., economic factors involved in meeting the costs of health services, and the opportunity costs involved; and (iv) availability, i.e., the extent to which health services are available for women (John, Lalita 1995). For a combination of difficulties in all these possibilities, most women in rural areas continue to use local remedies which include home remedies. The traditional knowledge and practices that were earlier available at the household level, however, are disappearing. The efforts to restore them are few and insufficient to make an impact on the larger reality.

The consequence of all these, however, is an accumulated burden of illness and undernutrition. This is clearly reflected on the estimates of disability adjusted life years (DALYs), despite the criticisms that this indicator has received (Kothari, Gulati 1997). The estimates of global burden of diseases reveal that when the average years lived with disability (YLD) is 1.7% in the developed countries, it is as high as 7.9% for the developing ones. Moreover, iron deficiency anaemia in developed countries is not even within the 10 leading causes of DALYs in the age group of 15–44 years, irrespective of their sex groups, while it is an important factor for both women and men in the DCs. However, while for men it is the tenth cause, for women it is the third leading cause of DALYs (Murray, Lopez 1996).

The pressure that the driving forces create on women in DCs is a complex process. It results in low access to food, accumulated burden of ill health, and nutritional deprivation. These, in turn, leads them to deficiency of single or more nutrients and perpetuation of the vicious circle between undernutrition and ill health. The effect is obviously nutritional deficiency disorders amongst women including maternal malnutrition. The latter then becomes a cause for producing LBW babies, placing them at the risk of further undernourishment.

Methodological issues

The existing literature has contributed to a certain understanding of various dimensions of the relationship between women's under-nutrition and domestic environment in DCs. However, there is still a great need for sensitizing research towards a gender-sensitive understanding of the relationship.

The available indicators continue to be a major problem for assessment of undernutrition among women. Though they can rank the population according to the prevalence of deficiency disorders, estimating the prevalence of the non-healthy population by using a cut-off point becomes difficult. Moreover, indicators of malnutrition are much less understood and characterized for adults as compared to young children. And among women, more attention has been paid to those indicators which are useful for assessing nutritional status and determining potential medical risk during pregnancy than for any period of life cycle. Very little is known about the assessment of nutritional status among non-pregnant, non-lactating women. The dilemma of standards and reference population continues to exist in research (Rasmussen, Habicht 1989). Studies on emergency situations such as the famine in Somalia during 1991/92 have also thrown up some methodological problems. Boss and others (1994) evaluated various survey methods used in 23 national surveys documenting malnutrition, common causes of morbidity, and mortality. While the results of some of these studies may have influenced policy and programme-management decisions, their effects have been limited. Differences prevail in objectives of the studies, their design, parameters measured, methods of measurement, definitions, and analyses. There is a need for clear definition of objectives, standardization of sampling and data collection methods, and ensuring documentation of study objectives, methods, and results.

Due to lack of sufficient data, variations in population are not very clearly understood. The prevalence and importance of nutritional deficiencies are likely to vary greatly among women not only from their men with regard to their biological and social differences, but also from women living in different domestic environments. For instance, the rural and urban settlements create different domestic environments for women. This may also vary depending on the socio-economic status of the households. Interestingly, even within households in the same socio-economic category, the prevalence and importance of nutritional deficiencies are likely to vary greatly in

women at different stages of their lives. They live under quite different circumstances in relation to their roles. Besides, regional differences have already been pointed out by Harris (1995). Others (Rasmussen, Habicht 1989) have also reported that data on the consequences of malnutrition on the performance and survival of women throughout their life cycles is almost negligible.

Thus, the relationship between women's nutritional status and domestic environment may vary according to region, urban or rural environment of households, socio-economic position, gender differences in the population, and also according to the phases in the lives of women and the roles that they play in home-making. Any research attempt to further explore the relationship in DCs needs to take the above issues into account. While population surveys would estimate distribution and magnitude of the problems and their social determinants, supportive clinical and experimental studies may explain or provide deeper insights into various dimensions of the relationship. Such combination in research would provide a strong base for the formulation of policies.

Policy interventions

Discourses on how to cope with the problem of undernutrition in DCs revolve around ensuring 'food security' at the household level. Food production, economic access to available food, and nutrition security are the pillars of food security. Though rise in the household income directly results in the rise in calorie intake in food to a certain extent, there is a need for other concomitant policies to accompany increases in income in order to attain food security (Alderman, Garcia 1993). Similarly, agricultural development *per se* is not the answer to the problem in the developing world where the rural economy is diverse, and not dependent on agriculture alone. Subsidy stabilization to reduce food prices may be considered an important step, as removal of government subsidies has been followed by an increase in the prices of basic foodstuffs, decrease in real wages, and soaring unemployment giving rise to extremely adverse conditions in many of these countries. These adverse forces have been the major hurdles to be handled through policy changes (UN 1991). However, development of education and infrastructure facilities, improvement in public health and sanitation, and other developmental activities have also been proposed subsequently (Alderman, Garcia 1993).

It is interesting that women, despite being denied just social status in many aspects of their lives, are considered as 'the key' to ensuring food security at the household level. In DCs, they meet the food and nutritional needs of their families as food producers, as providers of food to the household and contributors to household nutrition security. The policy recommendations are in three broad areas. First, women's physical and human capital needs to be increased. Women's ability to produce food can be enhanced by improving their access to resources, technology, and information. Literacy training for women and increased education for girls will increase productivity. Second, policy-makers must increase women's ability to generate income to maximize the benefits of women's income for household food security and nutrition. Income in the hands of women contributes more to household food security and child nutrition than income controlled by men. Strategies should aim at increasing women's productivity both in paid work and in domestic production, so that women can increase their incomes without sacrificing additional time, their children's welfare, or their own health and nutritional status. Third, the policies must protect women's health and nutritional status to allow them to fulfil their productive and reproductive roles. Development or safety net programmes for women should increase women's income-earning potential while reducing the energy or time intensity of their activities. Other programmes should address girls' and womens' specific health needs and empower women to seek health care for themselves and for those who depend on them for food and nutrition security (Quisumbing, Brown et al. 1995). However, empowerment needs to be understood as a collective process focusing on cooperation to challenge power relations, rather than individualistic activities (Oxaal, Baden 1997). Also, given the evidence in South Asia, that distribution of food and other resources such as health care is biased against the female sex, increased food security in the household does not necessarily ensure women's nutrition and health.

Moreover, the ideas behind such approaches are not always honoured in practice. Lack of understanding of social processes may often lead to the development of gender-neutral projects. For instance, in environmental projects where 'women were viewed as major local assets to be harnessed in the interests of better environmental management', proved to be gender-neutral in reality (Joekes 1996). A communal forestry project that attempted to address wood shortage in rural Ghana was biased towards men. A fall in the availability of wood fuel not only increased women's labour, but also affected the nutrition

intake as women had to reduce cooking time and cut meals. As an intervention, the project promoted neem trees which were used by men for construction work rather than the species used by women for wood fuel (Baden, Green et al. 1994 a). Similarly, the Bangladesh cyclone response failed to meet women's needs. Women suffered most following the 1991 cyclone and flood. Death rate in women was nearly five times than in men. Besides the reasons that women were malnourished and physically weaker as compared to men and were less mobile due to their traditional dress (sari) and due to lack of *purdah* in public shelters, they were left at home to care for the children and protect property (Baden et al. 1994 b). In another project on hand pumps in Kenya, the resistance initially came from men against women taking new roles (Baden 1993).

The move, from making women visible to making policies less gender-blind, is not a simple step. It involves not only the capacity to recast familiar and well-used policy tools for a whole new dimension of analysis, but also questions the scope of some of these tools for such analytical tasks. Recasting tools towards a more gender-aware policy raises a few important methodological challenges. It primarily calls for a fresh look at the basic units of analysis, primarily the household. The aspects of gender asymmetry that are most invisible to policy-makers, and at the same time, are powerful in deterring policy outcomes, are hidden within the 'black-box' of the household. The policies need to be renewed and directed towards a proper understanding of the basic analytical unit of the households – its diversity and complexity as micro-level realities, based on which other tools of macro-economic policy have to remodel themselves (Karen, Coffey 1996). As Kabeer (1995) has correctly pointed out that unless the extent of production and effects of gender inequalities are properly understood and integrated into policy formulation, the most radical strategies for change will continue to fall short of gender equity.

In brief, understanding women's situation within the household becomes a prime requisite for the formulation of policies regarding their nutrition. Not only is data on women still seen as only marginally relevant to policy-making, reliable sources for such data are also lacking in DCs. Moreover, gender-disaggregated data alone cannot provide insights into the social processes that determine the differential impacts of policies on women and men. For policy-making, such data must be accompanied by analytical framework to understand gender relations. There is also a need for gender-friendly epidemiological research, and filling in the gaps that exist in

formulation of policies. Studies can be designed incorporating gender-just approaches, in various dimensions of the problem of women's nutrition *vis-à-vis* domestic environment. Simultaneously, gender sensitization of the government machinery is yet another need. This may include methodological analysis of the census data, inçorporation of gender indicators into the database of various policies related to economy or poverty, labour, food, health including nutrition and education. In addition, gender training of the staff and creation of gender-sensitization cells may be other steps forward. Linking non-governmental organizations and women's organizations with governmental activities of policy-making is also necessary. Though experiences in countries like the Philippines brought some hope in this regard, the links elsewhere were not always straight forward. Diverse interests and priorities of various institutions often come in the way (Oxaal 1996). Nevertheless, with careful criteria for selection of organizations, collaborations could become productive in the efforts of reflecting and representing women's interests, to make the dream of their nutrition come true.

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About TERI

A dynamic and flexible organization with a global vision and a local focus, TERI was established in 1974. While in the initial period, the focus was mainly on documentation and information dissemination activities, research activities in the fields of energy, environment, and sustainable development were initiated towards the end of 1982. The genesis of these activities lay in TERI's firm belief that efficient utilization of energy, sustainable use of natural resources, large-scale adoption of renewable energy technologies, and reduction of all forms of waste would move the process of development towards the goal of sustainability.

A unique developing-country institution, TERI is deeply committed to every aspect of sustainable development. From providing environment-friendly solutions to rural energy problems to helping shape the development of the Indian oil and gas sector; from tackling global climate change issues across many continents to enhancing forest conservation efforts among local communities; from advancing solutions to growing urban transport and air pollution problems to promoting energy efficiency in the Indian industry, the emphasis has always been on finding innovative solutions to make the world a better place to live in. However, while TERI's vision is global, its roots are firmly entrenched in Indian soil. All activities in TERI move from formulating local- and national-level strategies to suggesting global solutions to critical energy and environment-related issues. It is with this purpose that TERI has established regional centres in Bangalore, Goa, and Guwahati, and a presence in Germany, Moscow, and Japan. It has also set up an affiliate institute in Washington, DC, USA – the Tata Energy and Resources Institute, North America (TERI–NA).

TERI celebrates its silver jubilee in 1999/2000. With a staff strength of around 500, drawn from multidisciplinary and highly specialized fields, and offices and regional centres equipped with state-of-the-art facilities, TERI has come a long way in these 25 years. As the Institute has grown in size and reach, so have its activities grown and diversified, and TERI is now the largest developing-country institution working to move human society towards a sustainable future. And, well on its way to becoming a Cybercorp, TERI also makes effective use of the latest developments in modern information technology in both its in-house and outreach activities.

Today, TERI is poised for the 21st century, driven by a philosophy that emphasizes and assigns primacy to enterprise in government, industry, and individual actions.

About UNEP

The United Nations Environmental Programme (UNEP) was established in 1972 and given by the United Nations General Assembly a broad and challenging mandate to stimulate, coordinate, and provide policy guidance for sound environmental action throughout the world. Initial impetus for UNEP's formation came out of the largely non-governmental and antipollution lobby in industrialized countries. This interest in pollutants remains, but right from the early years, as perceptions of environmental problems broadened to encompass those arising from the misuse and abuse of renewable natural resources, the promotion of environmentally sound or sustainable development became a main purpose of UNEP.

From the global headquarters in Nairobi, Kenya, and seven regional and liaison offices worldwide, UNEP's staff of some 280 scientists, lawyers, administrators, and information specialists carry out UNEP's programme, which is laid down and revised every two years by a Governing Council of representatives from its 58 member states. These members are elected on a staggered basis for four years by the United Nations General Assembly.

UNEP's mission is to provide leadership and encourage partnership in caring for the environment by inspiring, informing, and enabling nations and peoples to improve their quality of life without compromising that of future generations. Broadly, UNEP's programme aims to stimulate action on major environmental problems, promote environmentally sound management at both national and international levels by encouraging the application of assessment results, and make such actions and findings known to the public – from scientists and policy-makers to industrialists and schoolchildren. The programme is run in cooperation with numerous other United Nations agencies, governments, intergovernmental organizations, non-governmental organizations, and specialized institutions.

In recent years, UNEP has strengthened its regional delivery and adopted a more integrated approach. Activities are now grouped under five programme areas: sustainable management and use of natural resources; sustainable production and consumption; a better environment for human health and well-being; globalization and the environment; and global and regional servicing and support. The programme is implemented through six divisions: Environmental Assessment and Early-Warning; Environmental Policy Development and Law; Environmental Policy Implementation; Technology, Industry and Economies; Regional Cooperation and Representation; and Environmental Conventions.

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The household environment of the poor people, especially women and children in the developing countries, carries the biggest risks to health. These risks are typically 'traditional' in nature, i.e., they are associated with a lack of development. Household environmental problems typically include overcrowding, lack of sanitation and garbage disposal, indoor air pollution, and vector-breeding grounds. It has been estimated that about 30% of the global burden of disease could be averted by improvements in the household environment and of these, 20% are just modest interventions.

This book is an assessment of the state of knowledge, contemporary situation, and status of scientific data that links domestic environmental parameters to the health of women and children. It aims to identify critical knowledge gaps and needed research. Policy options, guidelines, possible interventions, and regulatory tools to improve women and child health have been provided. Housing, fuel shortage and indoor pollution, water supply and sanitation, and nutritional status have been reviewed in this book. Given that the health problems associated with the domestic environment mainly affect women and children, gender issues are a strong component of this study. The book provides examples of how social and political backgrounds determine women's activity patterns at home and at work, and how this consequently affects their health.

Finally, the book recommends interventions and forwards arguments to modify current environmental regulatory tools and policies to achieve sustainable health improvement for women and children.