

**A REVIEW OF THE HEALTH IMPACTS OF PERT-URBAN
NATURAL RESOURCE
DEVELOPMENT**

**for the Natural Resources Systems Programme
of the Department for International Development of the United Kingdom (ex
ODA)
administered by Natural Resources International**

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Executive summary

- All development projects have indirect impacts. They can be positive or negative and affect the physical and social environment and human health. Projects which adversely affect human health cannot be sustainable. Projects which ignore health impact simply transfer hidden costs to the health sector which is poorly budgeted and unable to cope. If the health of either producers or consumers is adversely affected then the productive potential is probably reduced.
- The audience for this review are non-health specialists. They include the managers of natural resource projects, researchers and the recipients of development aid. The review provides the detailed reference material from which dissemination products can be constructed for each target group.
- Poor peri-urban communities live and work in a transition zone between rural and urban. They are confronted by both traditional and modern health hazards in the worst of both worlds. Increases in natural resource productivity carry the risk of increasing both kinds of health hazard. Transition theory provides an analytic framework.
- A chapter on each of the main peri-urban natural resource themes is provided. There is also a chapter on common cross-cutting issues, such as labour migration and food safety. Each chapter begins with a summary of the health hazard linkages identified. For example, enhanced agricultural production promotes health by alleviating poverty but the redistribution of wealth within the household can promote malnutrition. Diversion of surface waters for irrigation promotes production but, in Africa, it promotes the vectors of malaria, schistosomiasis and filariasis. A range of chemicals are applied intentionally to crops, but poor methods of application cause poisoning. A further range are applied unintentionally through wastewater re-use at various rates of dilution and toxicity. Wastewater re-use, poor handling and storage can transfer pathogens to food products, causing diarrhoea, dysentery and various intestinal worm infections. Recent cholera outbreaks have been attributed to poor urban agricultural practices. Increased use of fast moving machinery for field preparation, harvesting and processing lead to increased injury rates as well as dust-induced lung diseases and other occupational diseases. Livestock are responsible for a range of communicable diseases including brucellosis, tapeworm and salmonellosis. Psycho-social illnesses are created by change and stress, emphasising the social as well as physical environment.
- The report organises health issues into categories of communicable diseases, non-communicable diseases, injury, malnutrition and psycho-social disorder. Communicable diseases include malaria and diarrhoea. Non-communicable diseases include those attributed to toxic chemicals, dusts and moulds. Unintentional injuries from motorised transport have reached epidemic proportions in congested areas while homicide is a leading cause of death in some age groups. Malnutrition is associated with a transition from under-nutrition to over-nutrition and changes in cropping patterns. Psycho-social disorders leading to stress, depression, suicide, domestic violence and substance abuse are associated with overcrowded and polluted living and working environments.
- A method of prospective health impact assessment is described that can help ensure that health safeguards are included in project design and operation. Assessments should consider the community, environmental and institutional risk factors. The community risk factors include physiological status and behaviour. For example, in some areas there is partial immunity to malaria and then women and children are the most vulnerable. The environmental risk factors include bio-physical and social factors. For example, malaria mosquitoes require relatively unpolluted water. The institutional component includes the capacity, capability and jurisdiction of health protection agencies. For example, irrigation managers control the flow of surface waters that provide mosquito breeding sites.
- There are many opportunities for safeguarding health through improved design, operation and management of projects. A hierarchy of safeguards is apparent from institutional through to personal. Specific techniques are described throughout the review. For example, vegetable produce is frequently contaminated with pathogens and requires careful control.
- An extensive literature on urban health research is reviewed. Much of this literature concerns effective methods of supplying water and sanitation through community willingness-to-pay for, participation in and ownership of services. A recent trend within the Healthy Cities Programme is a focus on healthy marketplaces.
- The final chapters provide a synthesis of important linkages and list the researchable themes that require collective natural resource, social and health specialist inputs. Examples include: effect of urban agriculture on psycho-social disorders; food plant uptake of pollutants, integration of health issues in GIS overlays, occupational health and safety of using biomass fuels, post-harvest decontamination of food crops; safe aquaculture systems; the rural-urban transition in relation to various health risks including malaria, respiratory illness and diarrhoea; and wastewater reuse.

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Acronyms and glossary

ARI	Acute Respiratory Infection
ASP	Activated Sludge Treatment plants
BOD	Biological Oxygen Demand
BSE	Bovine Spongiform Encephalopathy
CD-ROM	Compact Disk Read Only Memory
CGIAR	Consultative Group On International Agricultural Research
CJD	Creutzfeldt Jacob Disease
DALY	Disability Adjusted Life Year
DFID	United Kingdom Department For International Development (ex ODA).
DHF	Dengue Haemorrhagic Fever
DW	Dry weight
EHI	Environmental Health Indicators
EHP	Environmental Health Programme of USAID
EIA	Environmental Impact Assessment
FAO	United Nations Food and Agriculture Organization
GIS	Geographical Information Systems
GTZ	Gesellschaft fur Technische Zusammenarbeit, German overseas aid organisation
HACCP	Hazard Analysis Critical Control Point system for food safety analysis
HIA	Health Impact Assessment
HIV/AIDS	Human Immune Deficiency virus/ Autoimmune Disease Syndrome
HPD	Health and Population Division of DFID
HYV	High Yielding Varieties
IAP	Indoor Air Pollution
IDRC	International Development Research Council of Canada
LIED	International Institute for Environment and Development, London
IPM	Integrated Pest Management
KAP	Knowledge, Attitude and Practice
NGO	Non-Governmental Organization
NR	Natural Resource
NRED	Natural Resources and Environment Division of DFID
NRSP	Natural Resources Systems Programme of DFID
ODA	Overseas Development Administration, see DFID
ORSTOM	Institut Francais de Recherche Scientifique pour le Developpement en Cooperation, French institute for scientific and technical research for development
PEC	Primary Environmental Care
PM ₁₀	Particulate Matter < 10 microns
1 ³ U	Peri-Urban
PUI	Peri-Urban Interface
SSA	Sub-Saharan Africa
STD	Sexually Transmitted Diseases
TB	Tuberculosis
UNICEF	United Nations Children's Fund
USAID	USA Administration International Development
WHO	World Health Organization
WSP	Waste Stabilisation Ponds

1. Introduction

1.1 Summary

- The audience, context and purpose of the review are specified and terms are defined.
- The health risk transition theory is proposed as a predictive model of health problems along the rural to peri-urban to urban continuum.

1.2 Objectives

The objectives of this paper were stated in the project proposal and this is reproduced in Box 1. In other words, the objectives were to identify the kinds of health hazards that natural resource managers, researchers and users should be aware of, to describe how these can be assessed, to determine what other agencies are doing about them and to suggest topics for future research.

Box 1 Purpose of the review

- Identify and address issues of health quality arising from the pursuit of all purposes within the Natural Resources Systems Programme peri-urban interface production system.
- Review the research activity and donor agency involvement concerning health-related implications of production and productivity improvements in peri-urban interface systems and identify the main researchable issues.

The Purposes of the Natural Resources Systems Programme (NRSP) are summarised Box 2 (Overseas Development Administration Natural Resources Division Research Task Group 1994).

Box 2 Purposes of NSRP Peri-Urban Interface programme

- Management of peri-urban resources optimised through improved productivity, control of environmental degradation and energy efficiency improvements.
- Crop production intensified on a sustainable basis.
- Productive potential increased by greater use of waste materials and recycling of resources.

1.3 Why should natural resource systems programme participants be concerned about health?

1. The NRSP is aimed at sustainable increased productivity. A development project or programme cannot be sustainable if human health is adversely affected. Projects which ignore health impact simply transfer hidden costs to the health sector which is poorly budgeted and unable to cope. If the health of either producers or consumers is adversely affected then the productive potential is probably reduced, although this link may not be quantifiable. The dis-benefits are particularly important in vulnerable communities including the landless poor, the elderly, children and women. All causes of ill-health reduce the productivity of farmers and farm labourers, reduce the educational achievement of children, increase the health sector budget and thus produce a poor economic return on investment.
2. Problems of concern include the health impacts of waste handling and use in agriculture; agro-chemicals on farm workers and consumers, zoonoses and animal wastes; recreational/ open space and stress related to urban change; settlements. communicable diseases and injury; home gardening and nutrition.
3. Many of the causes of negative health impact can be traced to poor management of the formal and informal peri-urban sectors. This, in turn, is due to lack of inter-sectoral collaboration between municipal planning authorities and line ministries and poor information. A timely prospective assessment of health impacts can safeguard and promote human health by encouraging small adjustments in project design or operation.

1.4 Audience and scope

1. There is a need to make available information about the health impacts of environmental change to the various non-health specialists associated with the NRSP. This audience includes project managers, researchers, extension services, municipal authorities, national planning departments, non-government organisations, CGIAR organisations, farmers, consumers and students. The information should be free of jargon, easily accessible by project type and cross-referenced. The intention is to inform non-health specialists about health issues rather than to inform health-specialists about natural resource issues. This review will provide a reference document from which dissemination products can be constructed, to serve the specific needs of each

audience. It does not provide a textbook of tropical medicine. Those seeking such information should consult one of the many excellent texts available. For example, "Disease control priorities in developing countries" should be comprehensible to a wide audience (Jamison et al. 1993). In parallel with the preparation of this review, the World Health Organization have recently published a book on environment-health linkages (World Health Organization 1997a). This is a useful companion volume that provides a broader perspective on a number of relevant issues and is highly recommended. Similarly, those seeking an overview of urban environmental problems should consult "World resources 1996-97: the urban environment" (World Resources Institute 1996).

2. We also try to maintain a tight focus on issues relevant to the NRSP peri-urban interface production system. We do not attempt to define natural resources or peri-urban boundaries except where necessary to illuminate health issues.

1.5 Some definitions

Table 1 lists the definitions of peri-urban, health and health impact as used in this review. The principal purpose for considering health impacts is assumed to be for assessing the consequences of a planned intervention. This is referred to as prospective health impact assessment. The assessment can then be used to modify policy or project design or operation so as to reduce health risks and increase health benefits.

Table 1 Definitions

Peri-urban	A poorly planned and regulated mosaic of land, housing, agriculture and industry, in a state of rapid change, from which a city obtains some of its resources and to which it discharges some of its wastes. It is a transition zone between rural and urban.
Peri-urban interface	An area characterised by strong urban influences, easy access to markets, services and other inputs, ready suppliers of labour, but, relative shortages of land and risks from pollution and urban growth (Overseas Development Administration Natural Resources Division Research Task Group 1994).
Health (from WHO)	A state of complete physical, mental and social well-being and not merely the absence of disease or ill-health.
Health hazard	A potential harm.
Health risk	The likelihood that a health hazard will affect a particular community at a particular time.
Health impact	A positive or negative change in health risk that is reasonably attributable to a planned or unplanned change in the bio-physical or social environment.

1. There are no universally accepted definitions of peri-urban and a detailed definition is outside the scope of this review. Peri-urban settlements can be defined by what they lack as well as what they have. They frequently lack basic infrastructure and services and are found on marginal, inaccessible or fragile land. They have unreliable water supplies, low levels of sanitation services and high population densities. Municipal authorities frequently do not have jurisdiction over them and are unable to extend to them basic services (Varley et al. 1996). There are conflicts over land uses and urban industries move into them to escape restrictions. The community is often heterogeneous with respect to ethnicity, income level, language and social norms. Misunderstandings between groups with different social customs are common. For all these reasons, peri-

urban areas may be more complex than either rural or formal urban communities and present unique challenges.

2. Peru-urban areas have high growth rates and may receive 70% of new migrants (Atkinson and Merkle 1993). They are also characterised by a high degree of population mobility (K. Smith *pers. comm.*) and according to whether residence is legal or illegal and the extent of residential mobility. Land ownership and land speculation at the edge of cities are also important driving forces that may impoverish farmers, displace them from their land and extend agriculture into new and more fragile rural areas. The same process may accelerate the rate of urban migration. The peri-urban community grows from the addition of urban people moving outwards as well as rural people moving inwards (Drakkakis-Smith, *pers. comm.*). The outer boundary continuously expands into rural areas and the inner boundary becomes urban.
3. The outer boundary may also be defined as the limit of travel of daily market produce (J. Smit, *pers. comm.*). This limit varies according to road condition, method of transport and rate of deterioration of the produce. It varies for each crop.
4. No specific literature related to peri-urban health was identified during the course of this review, but many references to poor urban communities are probably classifiable as peri-urban. Except where specifically indicated, references to peri-urban conditions are based on this assumption. Box 3 illustrates some of the linkages between natural resources and health in an urban community as viewed from the health perspective. The relevant natural resource issues are street foods, land tenure, flooding, water supply and sanitation, cooking fuels, traditional medicines and municipal planning.

Box 3 Health in a poor urban community in Nigeria

A report from Lagos paints a graphic picture of a poor urban community during the 1980's (Akin Aina 1990). This is assumed to have peri-urban characteristics. The land included a linear strip either side of the railway line where the Railway Corporation had constructed and rented out metal shacks. Much of the remainder was owned by private landlords. The occupants were surveyed and disaggregated as those in formal employment as labourers and those self-employed (39%). Over 50% carried out their occupation in or near to the settlement. Sale of cooked and uncooked foodstuffs by petty producers was a common activity and involved about 3.5% of the self-employed. Artisanal activities such as tailoring were also numerous.

A land use survey of the 35.3ha indicated 66% officially commercial, 9% public/government, 6% roads and 20% undeveloped or open land. Prevailing regulations, bye-laws and building codes were largely ignored. About 50% of the residents held their land on leaseholds of less than 5 years. This was regarded as unusual and the result of commercialisation and sub-letting. There was also a general sense of insecurity because of continuous threats of government acquisition for development purposes.

Some of the land was in low lying and swampy depressions and subject to serious flooding. Accommodation was very crowded and many households had less than one square metre per person in their rooms. The majority of households shared a bathroom and toilet. Bathrooms had a soakaway for wastewater disposal. About 88% of toilets had a bucket-latrines and about 12% had a pit latrine. The number of latrines was inadequate and open defecation was common. About half the residents did not use a kitchen but cooked in corridors. Most cooked on kerosene stoves. Fire outbreaks were common. The neighbourhood scored high on a deprivation index: building structures were fragile, waste disposal was poor or absent and drains were blocked. Drinking water was obtained from piped sources, wells and vendors in about equal proportion. About 80% of those surveyed did not have piped fittings that could be connected to public mains, although central pipe-borne water systems had been installed in the area since the 50's.

A survey of health care provision indicated that there was little or no government services but plenty of private pharmacists and traditional medicine sources within the community. The residents identified their most common illness as malaria followed by measles and dysentery/diarrhoea. The respondents identified environmental improvements, such as flood control, as a health priority. The report analysed the negative attitudes of those in authority towards poor settlements and the possibilities provided by local community organisation for community participation in various housing and habitat improvements

1

.6 Organisation of the report

This report seeks to group human ill-health issues into a minimum set of categories that will assist readers to understand the linkages with natural resources and the kinds of interventions that are required. The bulk of the report describes these health issues for each of the natural resource categories used by NRSP. The report also explains how health issues can be assessed for a specific project and how the risks should be managed. The

last chapter of the report lists recommendations for future research on the interface between resource management and human health. A list of acronyms is provided at the beginning of report and a detailed glossary is included in an annex.

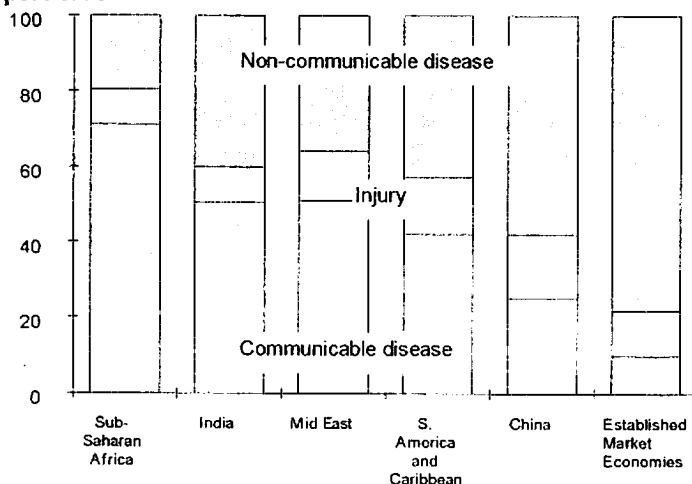
1.7 Theoretical framework

- As countries develop they experience a process of transition which is related to their economic condition but affects their population birth and death rates, nutritional standards, environmental conditions and their health status (Kjellstrom and Rosenstock 1990; Rossi-Espagnet et al. 1991; Smith 1991b; Bobadilla et al. 1993; Environmental Health Project 1995; Environmental Health Project 1996; Popkin 1996; Smith 1997). This transition process provides a theoretical basis that will assist in the assessment of peri-urban health impacts. It can be viewed at three levels:
 - between countries and regions,
 - between cities,
 - between rural and urban communities.
- Two major categories of ill-health can be distinguished: "traditional" health hazards and "modern" health hazards. The traditional health hazards are largely communicable or associated with under-nutrition. The modern health hazards are largely non-communicable or associated with over-nutrition, injury and psycho-social disorder. The health transition theory predicts that traditional health hazards fall and modern health hazards rise during development.

1.7.1 Between countries and regions

Evidence for epidemiological changes between countries and regions is most clearly visible at the regional level. Figure 1 illustrates the changing contribution of communicable disease, non-communicable disease and injury to morbidity in different regions measured in Disability Adjusted Life Years (DALYs) (World Bank 1993). Communicable diseases are a dominant contributor in sub-Saharan Africa and are replaced by non-communicable diseases in other regions. Malnutrition contributes 14% of the burden of non-communicable diseases in Africa and this falls to 6% in China and 2% in established market economies. By contrast, cancers contribute 2% in Africa, rising to 24% in established market economies. Transport injuries contribute 12-14% to the burden of injury in Africa and India, rising to 38% in Latin America and the Caribbean.

Figure 1 Percentage distribution of DALYs by region and hazard category, from World Development Report 1993



1.7.2 Between cities

- A similar transition has been observed between cities at different stages of economic development. Table 2 illustrates the changing pattern of mortality between two cities at different stages of development (Stephens et al. 1994). The variation in infectious and parasitic disease is attributed to the shortage of water, toilets, solid waste disposal in Accra together with reliance on biomass fuels (McGranaham et al. 1996). The high rate of injury in Sao Paulo includes homicides and other intentional injury. An equivalent set of dramatic differences can be expected between the cities in the NRI study: Kumasi, in Ghana, and Hubla-Dharwad in India.

Table 2: Comparative mortality in two cities at different stages of development (Stephen et al 1994)

	Accra Metro	Sao Paulo (City)
Circulatory	24%	33%
Respiratory	12%	12%
Infectious & Parasitic	18%	4%
Injury	4%	14%
Other		

1. The study divided the city of Sao Paulo into 4 socio-environmental zones (Stephens et al. 1994). 44% lived in the worst zone characterised by low education and income, less sewerage, less water supply, high housing density. The traditional and modern diseases varied intuitively between the zones, but there were also age-related factors. The study concluded that the urban deprived must first survive the unsanitary insults of poverty in childhood and then the psychosocial effects of poverty in adulthood that appear to result in high rates of traumatic and circulatory disease. One lesson from this study is that development projects need to manage the psychosocial as well as the more traditional infectious health hazards. *See also urban health research in developing countries, p51.*

1.7.3 Between rural and urban communities

As Table 3 indicates, similar differences in mortality that have been observed between urban and rural communities in a single country (Harpham and Tanner 1995). There is a transition from communicable disease to non-communicable disease. In this data set, respiratory diseases were 50% more frequent in urban areas. The analysis is limited by a lack of disaggregated data, but broad distinctions can be drawn between rural and urban areas.

Table 3 Selected causes of mortality, Mexico, 1990, (from Harpham and Tanner 1995). Data have been rounded.

Cause of mortality	Rural rate	Urban rate	Relative risk
Diabetes Mellitus	17	38	2.2
Chronic lower respiratory disease	4	8	1.7
Congenital malformation	5	7	1.6
Heart disease	25	39	1.5
Malignant neoplasm's	21	30	1.5
Nephropathy	8	11	1.3
Injuries	22	27	1.2
Liver diseases	20	23	1.2
Septicaemia	3	4	1.2
Consequences of alcoholism	3	3	.9
Asthma	14	11	3
Pneumonia	34	24	.7
Malnutrition	20	12	.6
TB	9	6	.6
Other anaemias	8	5	.6
Acute lower respiratory infections	3	2	.5
Gastro-intestinal diseases	40	17	.4

1. The authors suggest that particular features of the urban poor that differ from rural and affect health include: dependence on cash economy-
 - settling on land that is environmentally hazardous,
 - overcrowding;
 - insecurity of tenure;
 - breakdown of traditional family structure;
 - children working away from the family.
2. The case of Mexico has been analysed in some detail as an example of a middle income country (Bobadilla et al. 1993). The transition theory has been broadened to distinguish at least four models corresponding to: the Western model, the accelerated model (e.g. Japan), the delayed model which describes the incomplete transition of many developing countries, and a protracted model. The last model takes account of the unequal distribution of wealth and health services and the widening gap between different communities in the same country. It also seeks to take account of a counter-transition - the re-emergence of epidemic diseases in areas from which they had been controlled or eradicated.

On the basis of the evidence presented above, a similar process of transition is postulated along the rural to urban continuum, at least for poor communities. The urban health hazards are typically non-communicable diseases associated with pollution, stress and diet as well as injury and violence. They include diabetes, heart disease and chronic lung diseases. Rural health hazards are more typically communicable - such as diarrhoea, malaria, respiratory infection - but also include the consequences of under-nutrition and poor child-birth practices. Peri-urban communities face the industrial pollution problems of developed nations at the same time as they face the lack of clean water and sanitation that developed nations have already overcome. They are in the worst of both possible worlds (Ashton 1992). They are beset by the urban, or modern, health hazards on the one hand and rural, or traditional, health hazards on the other (World Health Organization 1991b).

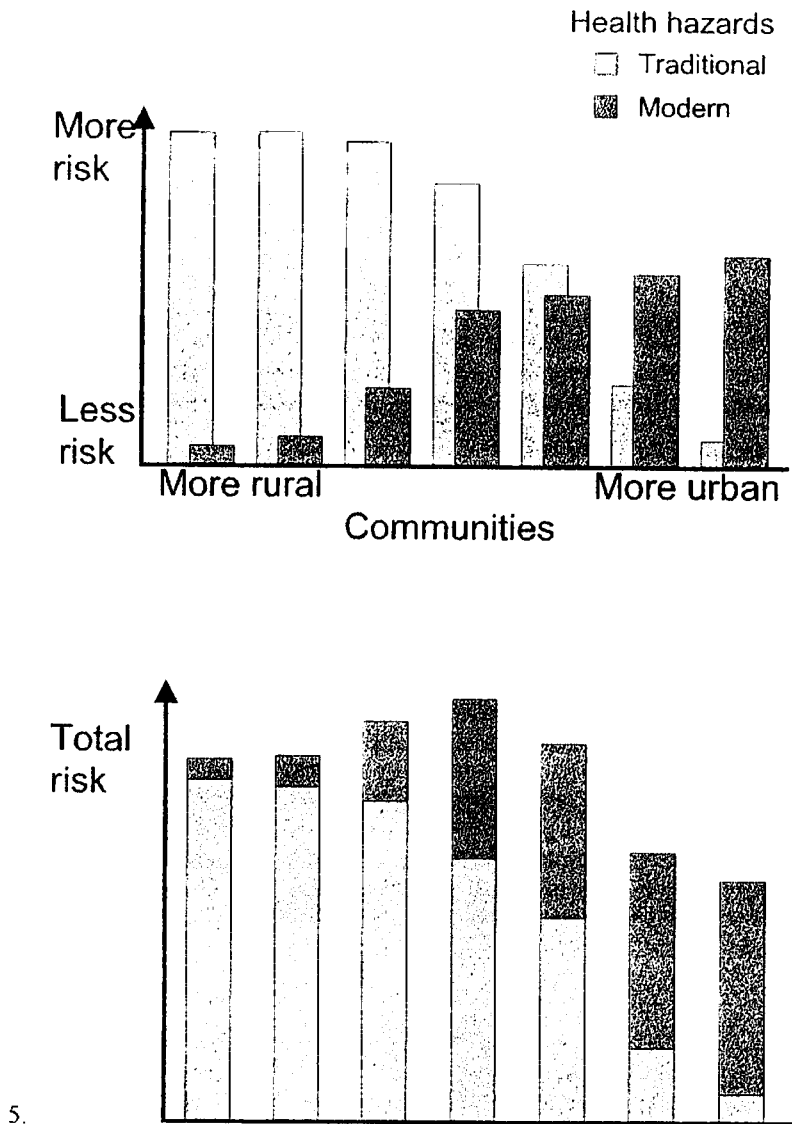
4. The health hazards faced by the urban poor can also be illustrated by comparing infant mortality rates. Table 4 indicates the observed differences in infant mortality rates between rural, poor urban and urban communities (Black 1996). The low-income urban communities were not classed as peri-urban but it is assumed that they may be so classified for the purpose of this review. The higher rates in the low-income urban group are striking.

Table 4 Infant mortality rates (per 1000)

	Year	Rural	Low-income urban	Other urban	National
Dhaka	1991	93	142	68	116
Managua	1987	60	60	50	56
Port-au-Prince	1983	66	200		110
Karachi	1985		95+	32	120
Sao Paulo	c1983		175	42	80

1. The change in disease patterns from traditional to modern is due to changes in the underlying risk factors (Smith 1991b; Smith 1997). For some diseases the link is immediate and direct. For example, if there are no mosquitoes then there is no malaria. In these cases, monitoring changes in morbidity provides an indication of changes in the risk factors. However, when diseases have a long latency period, such as some cancers, the linkage is delayed and there are often cumulative effects. Many of the health outcomes do not have a unique cause. Cancers and cardiovascular disease are multifactorial in origin; there are additive and synergistic effects. It is then necessary to monitor the risk factors in order to predict the future changes in health patterns. Smith argues that risks which are delayed and non-specific are poorly perceived by human communities and cites smoking as an example.
2. The traditional health hazards are partly the consequence of local environmental hazards. These have an immediate and local consequence for health. By contrast, the modern health hazards are the consequence of widespread environmental hazards created by the more affluent. They have long time lags and wider consequences; lead pollution is an example. The priorities accorded to these two groups of hazards in 19th century Europe and in modern developing cities have been analysed in terms of the political agenda of influential communities (McGranaham et al. 1996). They point out that in the 19th century the proposed solution was public expenditure on sanitation. The solution proposed today is to treat water supply and sanitation as commodities and let a free market determine the price. Opponents of this solution suggest that while privatisation may increase efficiency, the free market is not always appropriate for managing common property resources without regulation.
3. The organising principle for peri-urban health is illustrated in the Figure below (modified from Smith 1991b; Smith 1997). The peri-urban/urban environment consists of a mosaic of communities with substantial differences, so the health risk transition is represented in the figure as a set of communities in which health risks are distributed between traditional and modern. The communities on the left of the figure are poor and rural. Those on the right are wealthier and urban. Moving from poor rural to wealthier urban, traditional risks decline, modern risks increase and each follows an S shaped curve. The total risk is represented by the height of the columns and this also declines from left to right. The decline is not inevitable as emergent diseases and public violence affect the urban community. In the peri-urban zone the two sets of risks overlap and may do so synergistically so that the total risk rises. This zone represents the worst of both worlds.
4. Projects may reduce traditional risks while simultaneously increasing modern risks. The net change in risk may be higher or lower. There has been a tendency in risk impact assessment studies to focus on modern risks. The risk lowering and the risk raising aspects of development should both be considered. The challenge for NRSP is to choose development technologies that lower both kinds of risk for the majority of the community.

Figure 2 A rural-urban health risk transition hypothesis (modified from Smith 1991, 1997)



Other examples of the transition process include demographic, nutritional and institutional. For example, in Peru the overall population growth rate in cities is 3.8% but the growth rate in informal settlements is 6%. World-wide the urban population is expected to double in 10 years while the number of urban poor is expected to double in 5 years (Environmental Health Project 1996). The nutritional transition consists of a change from under-nutrition to over-nutrition: a switch from local staples containing complex carbohydrates to simpler sugars, fats and sweet drinks, as well as highly milled cereals and processed foods (Rossi-Espagnet et al. 1991; Popkin 1996). More foods are eaten away from the home and are purchased already prepared, often from street vendors. The institutional transition leads to increased intervention as the result of changes in organised social response. Environmental and occupational health hazards may continue to increase due to development activities, but the associated health risks may decline (Kjellstrom and Rosenstock 1990; Bobadilla et al. 1993). For example, the hazard of traffic injuries increases with the number of vehicles, but injuries per vehicle have declined in Europe because of increased use of seat belts, maintenance and defensive driving. Many services, including health, are more accessible in urban areas because they are closer and there is a wide choice of service providers.

2. Health hazard classification

2.1 Summary

- A system of health hazard classification is introduced. The classes are communicable disease, non-communicable disease, malnutrition, injury and psychosocial disorder. Examples are provided for each class.
- The classes provide an organising principle for the issues identified in later chapters.
- Problems of prioritising health hazards are outlined.

Table 5 Examples of health linkages with natural resource production

Development r	Communicable diseases	Non-communicable diseases	Malnutrition	Injury	Psychosocial disorders- :.....
Cross-cutting issues	Food handling and storage	Dust	Rural deprivation associated with labour Migration	Traffic occupational injury	Crowding, insecurity
Energy	Indoor air	Indoor air pollution	Loss of subsistence crops and wild foods	..	
Crop production	Vector breeding	Agrochemicals	Consequence of, aflatoxins	..	
Fisheries	Water-borne pathogens	Water-borne toxins	Loss of subsistence crops and wild foods	..	
Livestock	Animal products	Dust	Loss of subsistence crops and wild foods	..	
Recycling and waste	Vector breeding, sewage-borne pathogens	Hazardous chemicals			

2.2 Introductions

The classification of health hazards into traditional and modern has predictive value. However, in order to provide an organising principle for this report, a more detailed classification system is required. One system of classification that has been used in urban health research, but will not be used in this report, is summarised in Box 4.

Box 4 An international system for the classification of diseases

A system based on the International Classification of Diseases (World Health Organization 1977). The classes include:

- Infectious and parasitic (communicable diseases)
- Circulatory system (non-communicable diseases)
- Respiratory system (includes both communicable and non-communicable diseases)
- Mental disorders (including psychoses, conditions associated with drugs and alcohol, neuroses)
- External causes of injury and poisoning (including injuries caused by violence and traffic, drowning and many causes of poisoning including pollutants and pesticides)
- Endocrine, nutritional and metabolic diseases and immunity disorders (includes nutritional deficiencies or malnutrition).

This classification is primarily anatomical and illnesses are grouped by the organ system affected. Communicable diseases are the major exception and have largely been placed in a separate classification subdivided on the basis of causative agent. Bradley *et al.* proposed an alternative classification based on environmental causes such as shelter/built environment, water, waste and food (Bradley *et al.* 1992).

In the current review the following categories will be used, as these have proved useful in impact assessments in developing countries and easily comprehensible to non-health specialists (Birley 1995).

- Communicable diseases
- Non-communicable diseases
- Malnutrition
- Injury
- Mental and psycho-social disorders.

2.3 Communicable diseases

1. As explained in a previous section, the traditional health hazards associated with poor and rural communities are largely communicable, or infectious. In the peri-urban environment, these can be divided into sub-categories including:
 - vector-borne, such as malaria;
 - food-borne, such as salmonellosis;
 - water-borne, such as cholera,
 - air-borne, such as meningitis;
 - and human contact, such as HIV.
2. The infectious agent or pathogen may be a parasite, bacteria, virus, rickettsia or mite. In some cases partial or full immunity develops and the most vulnerable individuals are then children, migrants and the elderly. Human migration to the city can have a powerful influence, see Box 5 (Rossi-Espagnet et al. 1991).

Box 5: A typology of human urban migration and parasitic disease

- Infected persons enter non-endemic urban areas and provide a focus of infections. Examples include transmission of blood parasites by blood transfusion and transmission of soil geohelminths by poor hygienic conditions.
- Infected persons enter non-endemic urban areas where vectors are present. Examples include the presence of *Anopheles* without malaria and vector snail breeding without schistosomiasis.
- Infected persons enter endemic urban areas. In this case there may be little change. Non-infected persons enter endemic urban areas. The susceptible migrant may experience acute and severe disease. Urban cutaneous leishmaniasis is cited as an example.
- Urbanisation of natural zoonotic reservoir. Leishmaniasis, Giardiasis, Cryptosporidium infection and plague are cited as diseases which have animal reservoirs such as rodents that adapt well to dense human communities.
- Vectors enter non-endemic urban areas. Bugs, lice, fleas and aquatic snails may be transported in immigrants belongings.
- Occupational exposure. The migrant must often work as a scavenger. Rates of intestinal parasitism in scavenger communities have been recorded that are higher than in neighbouring non-scavengers. Agricultural labourers in irrigated peri-urban vegetable gardens may be exposed to range of water-borne and water-contact pathogens including schistosomes, intestinal parasites, bacteria and viruses.

2.3.1 Vector-borne diseases

1. Vector-borne diseases are strongly associated with NR management because modification of the environment frequently changes the habitat in which the vector breeds. In the following table the first three rows are particularly important. The role of houseflies as mechanical vectors of diarrhoea disease remains unclear. They are probably not the main transmission route but nevertheless important because of their large numbers (Esrey 1991). A strong association has been observed in some areas (D. Chavasse, *pers. comm.*) and local communities sometimes associate flies with diarrhoea (Chavasse et al. 1996).

Table 6 Some vector borne diseases

Disease	Vector	Habitat in relation to NR management
Malaria	Anopheline mosquito	Usually rural but also urban in India. Rural vector may find a niche
Filariasis	Often Culex mosquito	Commonly in heavily polluted water associated with overcrowding.
Dengue, Dengue Haemorrhagic Fever and	Aedes mosquito	Solid waste that can hold rainwater and water storage containers.
Gastrointestinal	Houseflies	Organic refuse
Schistosomiasis	Aquatic snail intermediate host	Irrigation channels and rivers where people bathe
Chagas disease	Triatomine bug	Association with ed-urban livestock in Central
Plague	Rat flea	Food stores infested with rats
Other arboviruses and	Hard ticks	Imported livestock
Scabies	Scabies mite	Overcrowded human host
Epidemic typhus	B louse	Overcrowded and unwashed human host
Leishmaniasis	Phlebotom	Housing
Iron-deficiency	Bedbugs	Housing

1. Service (1989a) and Lines et al (1994) have provided comprehensive reviews of the association between urbanisation and vector borne diseases. Urban communities are exposed to a different spectrum of communicable disease than rural communities by the nature of their environment. The urban environment is crowded and brings susceptible and immune people into close proximity. There are less domestic animals to act as buffer between vectors and hosts but greater numbers of synanthropic rodents. The concentration of human waste creates a unique environment that certain vector and rodent species can exploit while other species are excluded. The spectrum of breeding sites is narrow but those types that do exist are in greater densities. Urban environments consequently have large populations of vectors and reservoir hosts but a smaller number of species and fewer natural enemies.
2. The most important vector-borne diseases are those transmitted by mosquitoes, particularly malaria, filariasis and dengue. Under favourable environmental conditions of water and temperature these vector mosquito populations can increase their population sizes very quickly. They avoid natural enemies by breeding either in transient water sources (*Aedes aegypti*) or in water too polluted for many potential predators (*Culex quinque fasciatus*). The peri-urban poor get the worst of both worlds. For example, in India they are exposed. to malaria transmitted both by rural *Anopheles culicifacies* and by urban *Anopheles stephensi*.

2.3.1.1 Malaria

1. Malaria is the most common vector-borne disease with several hundred million infections in some 100 countries. It is transmitted by anopheline mosquitoes and there are several hundred species of which about 50 are important vectors. In each locality there are usually only one or two important species. But each species has a unique combination of breeding site preferences and other behaviours. Broadly speaking, all like to breed in relatively clean water and therefore malaria is most common in rural and peri-urban areas. Peri-urban areas represent pockets of rural environment within the larger urban conurbation. During the dry season many towns and cities practice irrigated agriculture. Whether or not the associated surface waters are suitable for malaria vector breeding will depend on their cleanliness. Malaria prevalence varies greatly from one district of a city to another as a result of the mobility of its population, the abundance of breeding sites for the mosquito and the quality of housing and services (Rossi-Espagnet et al. 1991, Atkinson and Merkle 1993).
2. Malaria mosquitoes have adapted to urban environments in India and to a lesser extent in the Middle East and Brazil. In India, the urban vector is *Anopheles stephensi* which has adapted to breeding in containers such as overhead tanks and garden ponds. In Brazil, some cities have expanded very fast and retained rural features including the malaria vector *An. darlingi*. In the Middle East, *An. claviger* may have a similar role. In Africa, there are some signs of an adaptation to urban breeding sites but the main concern is with the rural pockets. This can occur where there is urban agriculture or large tracts of swampy ground. The main vectors breed in relatively clean surface water such as rain puddles and vegetated pools. It has been suggested that African cities have relatively more open space, abandoned land and cultivation than elsewhere which may be significant (Lines et al. 1994).
3. Many surveys in Africa have indicated an irregular gradient in malaria vector densities from the urban periphery, where they are high, to the centre, where they are very low. The main vector species are *An. gambiae*, *arabiensis* and *fanrestas*. A study in a coastal peri-urban settlement in the Gambia confirmed the relatively low malaria prevalence rates (2%) compared with rural areas (30-90%). Most cases occurred on the periphery of the township and vectors were probably breeding in garden wells and ricefields (Lindsay et al.

1990). Children who got malaria tended to have more mosquitoes in their homes and these were made of mud and had bedrooms without ceilings (Adiamah et al. 1993). Differences could not be explained by consumption of medicines such as chloroquine and few people used bednets. Smoke producing repellents were commonly used. A transect study in Dakar measured malaria densities from the border of a permanent marsh to the centre of the city. Malaria mosquito densities fell steadily, as did the blood parasite rate in children (Trape et al. 1992). See also Box 6.

4. Exceptionally, in Accra the malaria mosquitoes appear to have adapted to different breeding sites. Chinery traces the changes in malaria mosquitoes in Accra since 1911 (Chinery 1984). In the early part of the century *An. gambiae* s. l. larvae were present in only 2% of all domestic water receptacles and there were many ponds and pools which were not surveyed. By 1969, *An. gambiae* s.l. was found in 21% of all positive domestic water containers and was almost as common as *Ae. aegypti* in such habitats. It was also breeding in polluted ground pools, including pit latrines, with *Culex quinquefasciatus*. Earlier this century *An. f. tnestns* larvae were probably breeding in the few relatively clean streams and are now rare, as the streams are polluted.
5. In 1996, the most influential agency for tropical disease research funding published a policy analysis of future options for malaria research (Anderson et al. 1996). The most striking feature of this report was an almost total absence of reference to the environment or to environmental causes of malaria transmission. By placing research emphasis elsewhere, the report provides a window of opportunity for those who can work within a multidisciplinary environment, health and development arena and who can command the research resources to do so. Malaria is pre-eminently an environmental disease as its transmission depends on the malaria mosquito. All environmental management, modification and manipulation of tropical and sub-tropical environments is likely to have either a positive or negative effect on mosquito production, contact or survival.

Box 6 Peri-urban malaria in Brazzaville, Africa

In Brazzaville the two main mosquito species were *An. gambiae*, the malaria vector, and *Cit. quinquefasciatus*, a nuisance mosquito (Trape and Zoulani 1987). There were five potential *An. gambiae* breeding site categories were identified: banks of river and streams; wells and installations for watering vegetable gardens and crops, ditches, gutters and puddles in ruts and car-tracks on the roads; borrow-pits and drainage wells in plots under construction and various building sites; and marshy hollows on non-urbanised ground.

The main breeding sites colonised by malaria mosquitoes were in the small fertile valleys with clay soils watered by streams where vegetable crops were planted. The sites were riverbanks, adjacent hollows and the diverse installations used for watering crops. Because of their high agricultural value, these valleys had held out against urbanisation. The low marshy banks of streams in zones of poor soils had little agricultural value and had been rapidly urbanised. Rainwater sites such as ditches, ruts and puddles were rarely used. These sites were frequently polluted and favoured by *Cit. quinquefasciatus*.

Further analysis suggested that each new area of human settlement initially favoured the multiplication of breeding sites and high densities of *An. gambiae*. Later, the canalisation of surface water, domestic pollution and increased human density tends to eliminate breeding sites. Under high human densities the remaining *Anopheles* had low dispersal rates of under 500m.

The following table summarises the main results

	Rural	Peri-urban	Urban
<i>An. gambiae</i> , a malaria vector	-	37%	0%
% <i>Cu. quinquefasciatus</i> , not a malaria vector	-	63%	100%
Wet season <i>Anopheles</i> biting rate per person per night	>50	7	0
Malaria prevalence rate in children	75-90%	50-80%	<7%
Human population density	<50	150	200-250

1. Studies of malaria on and off irrigation schemes in W Africa are beginning to confirm that there are complex changes in the ratio of two vector species, *An. gambiae* and *An. arabiensis*, with consequent changes in malaria prevalence. One of these species is believed to be far more zoophilic than the other. Further work is required to determine whether there are more cattle in the vicinity of the irrigation schemes. The relative importance of entomological versus human behavioural factors has also to be assessed. A similar approach is required in the rural-urban transition. Additional factors in the peri-urban environment are likely to include the rapid turnover in susceptible, infective and immune communities as a consequence of circulation between city and countryside.

2.3.1.2 Filariasis

1. About 100 million people are infected with filariasis. The most important urban and peri-urban form is Bancroftian filariasis, transmitted by the mosquito *Culex quinquefasciatus*. It is prevalent in tropical Africa, India, parts of Asia, Caribbean and eastern Latin American seaboard. Exceptionally, this mosquito does not transmit the parasite in W. Africa. There are many areas where the species was considered rare before the 1940s/1950s but is now very common as a result of urbanisation. The mosquito breeds in water highly polluted with organic matter that is characteristic of dense human settlement. This includes wet pit latrines, blocked sewage systems and drains, cesspits and septic tanks. Many of these structures have been poorly designed. Drains are frequently blocked by solid waste as a result of ineffective garbage collection systems. Organically polluted stagnant water accumulates behind the blockage. Because of the association of the mosquito with polluted water, there is sometimes an irregular gradient in mosquito density from high densities in the city to low densities at the periphery. A study in India demonstrated the relative importance of different kinds of breeding site within one coastal town and this enabled control activities to be prioritised. The study mapped the surface area of potential breeding sites and measured the mosquito production of each type of site. It revealed that although there were large areas of flooded land, they were relatively unimportant. Small areas of soak pits were very productive for mosquito breeding. L-shaped drains were more numerous than U-shaped drains but the latter were more frequently blocked with rubbish and more productive (Cairncross et al. 1988). Filariasis control was not sustainable until other municipal problems, such as solid waste management, could be solved in an integrated fashion.

2.3.1.3 Dengue

Dengue occurs in urban epidemics and there may be about 50 million cases per year. It is spreading rapidly as a result of urbanisation and travel. A severe form of the disease called dengue haemorrhagic fever (DHF) is also spreading. There is no treatment so mosquito control is vital. The mosquito vector is mainly *Aedes aegypti* and to a lesser extent *Ae. albopictus*. Breeding sites are rain and drinking water containers. These include much solid waste such as tin cans, coconut husks, rubber tyres, water storage jars and buckets. Leaf axils may also be important and tree rot holes are probably the natural habitat. An important breeding site may be the water-butts used by peri-urban horticulturists. Yellow fever is also transmitted by this vector. Yellow fever is frequently fatal but a good vaccine is available and outbreaks are currently more sporadic.

2.3.1.4 Mosquito control

1. Solid waste contributes to the breeding sites of mosquitoes and houseflies. Consequently, solid waste management has a uniquely important role to play in the management of urban and peri-urban diseases such as filariasis and dengue. Filariasis vectors may also breed in various kinds of sewage treatment plants, such as reed beds, and these need to be designed accordingly. In India, peri-urban malaria is associated both with water tanks and with irrigation systems so that both types of breeding site need to be controlled by good designs. In Africa, there is a general concern about urban agriculture because it introduces pockets of rural land use into the urban environment and may contribute to vector breeding, depending on water sources. Storage of clean water in any industrial enterprise or domestic environment is important. Peri-urban areas of low lying and marshy ground need to be removed as a matter of course and this can often be achieved by landfilling. If the water is required then another option is aquaculture projects. These may provide an effective method of mosquito control provided that a range of fish species is included, ponds are restocked regularly and marginal vegetation is cleared. There is still little or no literature on the cost-effectiveness of malaria control by fish.
2. Mosquitoes breeding in latrines and other enclosed, stagnant, polluted waters can be controlled efficiently by the use of expanded polystyrene balls (Lines et al. 1994). Various chemical methods are available to control mosquito breeding. Microbial insecticides based on *Bacillus thuringiensis* and *sphaericus* fit well with IPM projects. The key research issue is the development of slow release, floating formulations. A recent product from Iran shows promise (Moazami 1994). Plant based larvicides such as Neem tree extracts may also have a role to play. Service provides an overview of urban mosquito control (Service 1990).
3. Adult mosquitoes can also be controlled by a series of measures (Lines et al. 1994). The use of impregnated bednets has been shown to effectively control disease transmission in many circumstances. There are also a range of repellents containing natural or synthetic chemicals that are rubbed on the skin or burnt. There is an opportunity to include plants containing these chemicals in natural resource development projects.
4. Many mosquito control measures are best undertaken by sectors other than the health sector. The health sector has neither the finance, the staff, the skill or the jurisdiction to manage solid waste, water storage or sewerage. There are important opportunities for collaboration between health and the natural resource management sector for vector control which would contribute to a truly sustainable concept of development.

2.3.1.5 Chagas disease

1. Chagas disease (American trypanosomiasis) is well recognised as a serious public health problem in Latin America. WHO estimates suggest 16-18 million people infected, with a further 100 million at risk and the World Bank now ranks Chagas disease as the most serious parasitic disease of the Americas, with an economic impact far outranking the combined effects of other parasitic diseases such as malaria, leishmaniasis and schistosomiasis (World Health Organization 1991 a; World Bank 1993). Infection with the causative agent, *Trypanosoma cruzi*, is often contracted during childhood, but the debilitating effects of the chronic infection (e.g. cardiac arrhythmia, insufficiency and life-threatening aneurysms) tend to arise some 10-15 years later in what should be the most productive age-groups. In spite of recent research developments, the infection remains incurable except during its very earliest stages, and vaccines are unavailable. Control therefore relies on halting transmission, by screening blood donors to avoid transfusional transmission, and by eliminating domestic populations of the insect vectors - large blood sucking reduviid bugs of the subfamily Triatominae (Schofield 1994).
2. Governments of the most affected countries now give high priority to the control of Chagas disease. The Southern Cone Initiative, launched in 1991, is a major programme designed to eradicate all domestic and peridomestic populations of the main vector, *Triatoma infestans*, throughout the endemic regions of Argentina, Bolivia, Brazil, Chile, Paraguay and Uruguay. Peru, where *T. infestans* is also the main vector in southern departments, joined the initiative in 1996. Elsewhere, similar initiatives are being developed for Andean Pact countries (mainly Colombia and Venezuela) and Central America (mainly Guatemala, Nicaragua, El Salvador and Honduras). In these regions the main target is *Rhodnius prolixus* which is entirely domestic in Central America but may retain sylvatic foci in some parts of Venezuela.
3. The Chagas control initiatives focus on rural areas where the infection is most prevalent, and have been highly successful, with the incidence of new childhood infections cut virtually to zero over wide regions of previously endemic areas (Schmunis et al. 1996). However, concern is now expressed for urban foci of the disease, which may represent unusual problems for the future. In general, this disease is not considered a predominantly peri-urban problem. In Central and South America there are peri-urban areas where transmission of Chagas disease by triatomine bugs is a matter of concern (C. Schofield *pers. comm.*). For example, an important vector in Central America inhabits dry stone walls. See Box 7.
4. A study of Chagas disease in Bolivia identified a rise in prevalence rates in the peri-urban area of Cochabamba, although rates remained far lower than in rural areas (Arata and others 1994). The study compared house infestation by the vector among new and old houses. The vectors were more intra-domiciliary than peridomiciliary in the peri-urban areas and this was attributed to a lack of domestic animals. In southern Peru, the presence of *T. infestans* in various isolated towns, and in the southern suburbs of Lima, is strongly correlated with motor transport. *T. infestans* was first recorded from Lima during the 1930s in houses around a market where lorries unloaded agricultural produce brought in from endemic rural areas in the south (Lumbreras 1972).

Box 7 Chagas disease transmission in Tegucigalpa, Honduras

Tegucigalpa, Capital City of Honduras, is an expanding conurbation geographically constrained by surrounding hills. Broadly speaking, the richer residential areas occupy the valley floor, while less well-off areas cluster over the surrounding hillsides. Expansion of the city correlates with the general rural-urban migration of people which has been widespread throughout Latin America over the last 20 years, although recent civil unrest in Central America has probably accelerated this general trend. Around 25% of the 5.6 million total population of Honduras now live in and around Tegucigalpa.

Studies carried out by the Central Reference Laboratory of the Ministry of Health over the last 10 years indicate reports of *Triatomra dimidiata* throughout the hillside communities of Tegucigalpa, with frequent reports of bugs also captured in houses in the richer residential areas. From the cumulative reports, over one-third of houses are considered to be (or have been) infested (C. Ponce, *pers comm.*). The source of these infestations is not entirely clear, although *T. dimidiata* is well known from rural areas throughout the Central American isthmus so that the urban infestations are primarily attributed to passive carriage amongst the belongings of rural families migrating to the city.

A feature of the peri-urban communities is the clustering of houses with complex networks of dry stone walls constructed by newly arrived families in order to enclose their domestic animals (mainly goats, chickens, and some donkeys and mules). These dry stone walls provide good habitats for rodents, and are widely infested with small *T. dimidiata* populations. The houses themselves are more usually constructed of wood or blocks; they are less frequently infested by *T. dimidiata* although true domestic infestations are sometimes quite heavy.

Control of *T. dimidiata* in the peri-urban communities is occasionally carried out in response to requests by the householders, by local spraying with residual pyrethroid insecticides. There have also been programmes to encourage householders to reconstruct the dry stone walls using cement mortar to seal the cracks, although this is recognised to be a costly and long term undertaking. Cement is expensive, transporting it up the hillsides is difficult, and there are now very extensive networks of dry stone walls. Rodent control programmes have also been considered, with the idea of depriving the bugs of what are probably their main hosts, but there is a fear that this could provoke more frequent domestic invasions by hungry bugs searching for alternative hosts.

2.3.1.6 Leishmaniasis

1. Visceral leishmaniasis is a severe parasitic disease transmitted by phlebotomine sandflies. In Brazil it is typically found in rural foci containing dogs and foxes as well as the vector. Rapid peri-urban expansion in north-east Brazil led to an epidemic in the city of Natal (Jeronimo et al. 1994). The expansion took place in a sparsely populated sand-dune ecosystem about 15km from the city where the disease was endemic. In one district, the population had increased from 485 in 1980 to 13250 by 1991. The vegetation was cleared for housing. Most of the new cases were in children and there was clustering of cases within households. The mortality rate was 10% and mostly of malnourished and debilitated children. There were also many inapparent infections.
2. In parts of the Middle East and Asia there is urban transmission of cutaneous leishmaniasis, or oriental sore. The vector, also a phlebotomine sandfly, appears to favour high density, low quality housing and construction sites in dry cities and peri-urban areas. Cities from which it has been recorded include Kabul, Teheran and Aleppo. People are the main reservoir host and the parasite is probably imported by migrant workers (Ashford, *pers. comm.*).

2.3.2 Water and food-borne parasitic diseases

1. There are a number of parasitic infections of importance at the peri-urban interface, each with its own age-prevalence rates and severity. The following table summarises some relevant aspects of the transmission, vulnerability and symptoms (Feachem et al. 1983). Note the environmental classification of latency, referring to a resting stage between excretion and infection, and persistence, referring to a period of survival in the environment. The most common pathogens are listed in Table 7, together with their mode of transmission, their symptoms and their environmental classification.

Table 7: Summary of some common pathogen features

Pathogen	Transmission	Symptoms	Environmental classification
Large <i>Ascaris</i>	Eggs ingested from soil, infective for By direct sunlight	Wasting at high doses	Latent, persistent
Hookworms, <i>Ancylostoma</i>	Eggs hatch in soil, larvae remain penetrate skin. depend on soil tvpe. Can from salads	Cause anaemia	Latent, persistent
Whipworm,	Eggs ingested from soil	Diarrhoea with blood, wasting	Latent, persistent
Strongyloides worm	Eggs hatch in gut, larvae found in soil, auto-infection occurs	Often asymptomatic, wasting diarrhoea	Latent, persistent
Beef tapeworm, <i>saginata</i>	Eggs ingested by cow/camel during raw or poorly cooked meat. Eggs survive months	Rarely serious, no	Latent, persistent,
<i>Hymenolelm lesser tapeworm</i>	Person-to-person	Often asymptomatic, diarrhoea	Non-latent, low
Bacillary <i>Shigella</i> bacteria	Faecal-oral, foodborne and waterborne,	Acute onset, fever and	Non-latent, medium to infective dose
Amoebic <i>Entamoeba</i> protozoa	Cysts excreted in faeces are ingested in water or food, flies are mechanical	Gradual onset, no fever, dysentery with blood mucous, sometimes abscess	Non-latent, low
Giardiasis protozoa	Faecal-oral, cysts	Persistent diarrhoea, malabsorption of food, Asymptomatic infection	Non-latent, low
Pinworm <i>Enterobius vermicularis</i>	Person-to-person	Negligible public health Importance	Non-latent, low
Infectious virus	Faecal-oral	Variable, can include	Non-latent, tow
<i>Salmonella</i> bacteria. includes typhoid	Faecal-oral and via food and water, zoonosis	Diarrhoea, some species Produce high fever	Non-latent, medium to infective dose
Cholera <i>Vibrio cholerae</i> bacteria	Faecal-oral and via food and water	Many cases are mild, cases have acute fluid Diarrhoea and vomiting	Non-latent, medium to infective dose
<i>Campylobacter</i> bacteria	Faecal-oral, zoonosis esp. poultry	Bloody diarrhoea	Non-latent, medium to infective dose
Cysticercosis <i>Taenia solium</i>	Pig meat	Sometimes neurological	Persistent
<i>Cryptosporidium</i>	human and animal reservoir, faecal-oral water	Diarrhoea, often	Non-latent, persistent
Schistosomiasis, bilharzia <i>S. mansoni</i> and <i>S. haematobium</i>	Infected water containing snail host	Bloody urine or stools, Debilitating, damage to over long term	Latent, persistent, host

1. Recent research suggests that there are two morphologically identical species of *Fruamoehu hislolylicer*, one pathogenic the other not. This discovery is expected to lead to important changes in the understanding of the epidemiology of dysentery.
2. Table 8 provides an indication of how some of these pathogens are treated.

Table 8 Some clinical treatments for common pathogens

Pathogen	Treatment
Some helminths	Mebendazole
Tapeworms	Niclosamide
Protozoa	Metronidazole
Bacteria	Antibiotics
Cholera	Fluid replacement and antibiotics
Some viruses	No specific treatment, but prevention 6
Schistosomiasis	Prazi uantel

The poor disposal of organic solid waste and scavenging by domestic animals such as cats, pigs and rats is associated with a range of foodborne parasitic diseases. The following table and accompanying notes summarise some of them (Murrell 1995). See also food safety, p51.

Table 9: Some foodborne parasites (Murrell 1995)

Disease	Source	Clinical features	Control
Toxoplasmosis	Pigs, sheep, cattle, poultry, cats, dogs	Congenital malformation	Cook or freeze meat, avoid faeces
Trichinosis	Pigs, horses	Diarrhoea, heart disease	Cook or freeze or cure meat
Taeniasis	Infected meat, ingestion of eggs	Diarrhoea, weight loss	Cook or freeze meat
Cysticercosis	Pigs, ingestion of eggs	Brain damage	Avoid infective human faeces and food contamination, prevent scavenging

1. Toxoplasmosis transmission is faecal-oral, congenital and through carnivorism. Cats are the main reservoir and contaminate the environment through their faeces. Infected meat of other domestic animals may infect humans. Pigs may be infected by scavenging on faeces and dead animals. Babies born to infected women and immune-suppressed individuals are most vulnerable.
2. Trichinosis transmission is by consumption of infected meat. Pigs may be infected by scavenging on food waste and dead animals.
3. Taeniasis and cysticercosis (tapeworm infection) transmission by domestic animals is by ingestion of eggs that contaminate the environment from faeces. Pigs may be infected by eating human faeces directly. Use of under-treated sewage in agriculture can lead to transmission. Consumption of infected meat may infect humans. There are two main species: beef tapeworms and pig tapeworms. The pig tapeworms are the most hazardous because humans may ingest eggs and serve as a host for the larvae that encyst in various organs. In some cases the brain is involved (neurocysticercosis). The disease is relatively common and frequently fatal or permanently disabling. For example, in Mexico it was estimated to cause 1% of all hospital deaths and 25% of all intracranial tumours at an estimated cost of \$195M per year (Murrell 1995). In order to control the disease in humans stringent abattoir regulations may be imposed. Condemning infected pig carcasses is an important source of losses to the meat market. In Mexico it was estimated that it cost the equivalent of 68% of total investment in pig production.

2.3.3 Zoonoses

1. There is a range of new diseases from animal sources and traditional zoonoses that are of concern to both veterinarians and public health specialists. *See also livestock, p51 and table 9.* Emergent zoonoses can be grouped into three main categories (Meslin 1992):
 - D Associated with changing farming practices, trade and consumer habits;
 - 0 associated with changing environments which affect reservoirs, vectors or final hosts; □ pathogens acquiring new properties through adaptation and mutation.
- 1 Foodborne enteric infections and intoxications have increased in both developed and developing countries (See above). These are associated with changing slaughterhouse practices. Salmonellosis and *Escherichia coli* are of particular concern and new pathogenic strains have appeared. The linkage between Cruetzfeld Jacob Disease (CJD) and Bovine Spongiform Encephalopathy (BSE) remains unconfirmed but is causing concern in many countries. Rift Valley Fever epidemics have occurred in several African countries in association with dam projects and livestock. There is speculation that influenza epidemics may sometimes have an animal reservoir, *See inlt ivrcrted aquaculture cnrd the risk of irifhrenzrr p(mclemics. p51.*
3. Aquaculture is one of the fastest growing areas of peri-urban development in some regions. There are a number of health hazards. Table 10 lists some of the pathogens associated with aquaculture. Most of the pathogens listed in Table 7 are also important, *Sue also aquaculture, p51.*

Table 10: Pathogens causing health hazards in aquaculture development (adapted from Cairncross and Feachem 1993)

Disease	Common Name	Pathogen	Transmission	Distribution	Water Relation
Clonorchiasis	Chinese Fluke	Clonorchis	animallman-snail-fish-man	SE Asia	Water based,
Diphyllobothriasi	Fish	<i>Diphyllobothnum</i>	animaltman-copepod-fish-	Worldwide	Water based,
Fasciolopsiasis	Giant Fluke	<i>Fasciolonsis</i>	man/pig-aquatic snail-aquatic man	SE Asia, mainly China	Water based,
Opisthorchiasis	Cat Liver	<i>Opisthorchis O. viverni</i>	callman-aquatic snail-fish-man	Thailand, former USSR	Water based,
Paragonimiasis	Lung Fluke	<i>Paragonimus westermani</i>	animallman-snail-man	East Asia, Africa, S America	Water based,
Leptospirosis	Wail's	<i>Leptospira spp.</i>	animal-man		Water bome, through skin, mouth or

2.3.4 Acute diarrhoea disease

1. Diarrhoea is a leading cause of infant and child mortality and morbidity. There are many sources of infection. Neighbourhoods with clean water supplies and functioning toilets tend to have lower rates of diarrhoea than those without. Contributory factors include early weaning and inappropriate treatment. Early weaning may be a function of the economic pressures on working mothers. Many studies suggest that although mother's frequently know about Oral Rehydration Therapy they may not use it when their child is sick but turn to commercial medicines.
- 2 Table 12 provides an example of the variation in childhood diarrhoea between communities in the Greater Accra Metropolitan Area (Songsore and MCGranahan 1993). A number of risk factors for childhood diarrhoea were identified. In the poorest economic groups about 48% of children defecated outdoors.

Table 12 Urban and peri-urban diarrhoea and environmental factors, Accra (from Songsore and McGranaham, 1993), percentages rounded upwards

	Rural fringe Or peri-urban	High density low-class	High density indigenous	Medium density indigenous	Middle class	High class
Water source						
Private	2%	53	49	46	88	96
Communal	16	2	28	4	8	0
Vendor	50	20	19	2	4	4
Toilet						
Flush	2	22	28	23	84	96
Pit/KVIP	92	46	46	55	9	2
Pan	0	29	25	13	4	0
Other/None	6	3	1	10	3	2
2 week prevalence children's diarrhoea	24%	14	26	5	4	5

2.3.5 Sexually transmitted diseases

Sexually transmitted diseases (STDs) are a major hazard associated with poverty and migration. They include HIV/AIDS. Poor women are often forced into prostitution as a result of a lack of alternative means of livelihood in the urban environment. Sexual contact is still the major mode of HIV transmission and prevalence rates are frequently higher in African cities than in the countryside (Rossi-Espagnet et al. 1991). Infection rates in urban prostitutes are frequently as high as 75%. High infection rates in the active working population are likely to undermine economic development, health care, child survival and social structure. AIDS is also likely to aggravate other infections, such as tuberculosis. The urbanisation process may, itself, increase the average number of sexual partners and contribute to the rate of infection. Natural resource developments which provide alternative economic activity and target poor women could have an important positive health impact.

2.3.6 Acute respiratory infection

Acute respiratory infections (ARI), including colds, sinusitis, tonsillitis, laryngitis, bronchitis, influenza and pneumonia, are an important cause of child mortality in both rural and urban areas. They represent 10-30% of all under 5 mortality in developing countries. They include both upper and lower respiratory tract infections and pneumonias caused by other infectious diseases such as measles, whooping cough and varicella. Measles represents an important percentage (Garenne et al. 1992). The annual incidence in children tends to be higher

in urban areas (Rossi-Espagnet et al. 1991)_ There are also important infra-urban differences. For example, mortality in a shanty-town in Brazil was 6 times higher than elsewhere. Indoor and outdoor air pollution are likely contributing factors, as are overcrowding and poor ventilation. ARI deaths generally decline with development.

2.3.7 Chronic respiratory diseases

There are intra-urban differences in the notification rates for chronic respiratory infections such as tuberculosis (TB), with higher rates among poorer people and poorer peri-urban areas (Rossi-Espagnet et al, 1991). There are linkages between TB and HIV infection and severe malnutrition. Overcrowding and poor ventilation are important contributory factors. Other risk factors include alcoholism, drug abuse, homelessness and poor compliance with treatment.

2.3.8 Meningitis

Cerebrospinal meningitis epidemics have been observed in a sub-Saharan meningitis belt. The belt includes parts of Sudan, Ethiopia and Chad. These are most severe in overcrowded urban slums and peri-urban areas, from which they tend to spread into formal urban areas (Rossi-Espagnet et al. 1991).

2.4 Non-communicable diseases

I. Non-communicable diseases can result from the ingestion, inhalation or absorption of toxic chemicals, including pesticides, minerals and heavy metals. In addition to intoxication they include maternal and perinatal mortality. They may be associated with air, water or foodborne pollutants, poor occupational safety or poor domestic storage. The symptoms may be acute or chronic. Acute poisoning from pesticides can lead to acetyl cholinesterase inhibition. The symptoms include dizziness, weakness and coma depending on dose. Chronic neurological symptoms include blurred vision, dizziness, numbness or headache and superficial or deep sensory loss (Amr et al. 1993). Other chronic symptoms of non-communicable diseases include heart and lung disease, various cancers and foetal damage. The symptoms of chromate poisoning associated with tanning and mycotoxins associated with mouldy food are discussed below. There is concern that industrial pollutants including lead may contaminate peri-urban crops and poison consumers.

Table 13 Some non-communicable health-hazards associated with peri-urban natural resources

Source	Substance	Health hazard
Tanneries	chromate	cancer, ulcers, dermatitis, foetal damage
Food	mycotoxins	cancer, malabsorption, immune deficiency, liver disease
Crop protection	pesticides	Neurological damage
Milling	dust	lung disease
Crops	lead	Neurological damage
Biomass fuels	ashes and particulates	Respiratory disorders
Wastewater	nitrites	infant respiratory disorder
Fruit processing	fruit acids	dermatitis

I. Vulnerability to pollutants is increased by malnutrition, communicable disease and human behaviour. In addition, pollution can increase susceptibility to communicable disease. Non-communicable diseases sometimes require long latent periods and may be associated with many sub-acute exposures to toxic substances. The substances themselves may be associated with well-defined point sources such as pesticide stores or contaminated wells. Control may depend on a general reduction in levels of use, emission and exposure. Chemical pollution can damage the resource base and destroy fisheries, make water unsuitable for irrigation, or damage crop vegetation and reduce agricultural productivity. The consequential health hazard is malnutrition due to food shortage.

2.4.1 Air pollution

1. Air pollution by industry, traffic, cooking fuels and thermal power stations contribute to chronic respiratory diseases such as bronchitis and asthma as well as acute diseases such as pneumonia. South American studies have documented the excess morbidity and mortality from respiratory disease attributable to air pollution (Rossi-Espagnet et al. 1991). *See also biomass fuels, p35 and fossil fuels, p37.*
2. Adverse health effects of air pollution have been associated with three major sources, as follows (Romieu et al. 1990).
 - Sulphur oxide and particulates from fossil fuels, for example the London smogs;
 - Photochemical oxidants and carbon monoxide from motor-vehicles, for example the Los Angeles smogs;
 - Miscellaneous pollutants such as hydrogen sulphide, lead and cadmium emitted by smelters, refineries, manufacturing plants and vehicles.

A close-response relationship between 24 hour exposure to particulates and excess deaths has been derived. Certain community groups are particularly sensitive to sulphur dioxide plus particulates which exacerbate the symptoms and frequency of asthma attacks. Long-term exposure effects include cardiorespiratory disease. Intra-urban differentials have been measured. Associations with chronic obstructive lung disease are suspected but masked by the many other risk factors.

4. Photochemical smogs consist of ozone, nitrogen oxides, sulphates and other chemicals. There may be synergistic effects but ozone seems to be the most biologically active component (Romieu et al. 1990). The effects include eye, nose and throat irritation, cough, pain, chest tightness, malaise and nausea and increased frequency of asthma attacks. Nitrogen oxides has been related to increased respiratory infection in children. Lead has been associated with impaired neurological development of infants and children. In Latin America, some 30 million children, 47 million adults aged 15-59 and 4 million elderly were estimated to be exposed to air-pollutant levels that exceeded WHO guidelines (Romieu et al. 1990). A study in Mexico City observed significant differences in the prevalence of upper respiratory infection between school children living in the centre and the industrial periphery and this was attributed to outdoor air pollution.

2.4.2 Arsenic and groundwater

1. Arsenic poisoning is an example of contamination of natural groundwater resources with a serious poison. Arsenic in drinking water at ~1mg/L levels from wells is associated with skin lesions, cardiovascular lesions, bladder and kidney cancer in a range of countries including Chile, Mexico, Taiwan, India and Bangladesh.
2. Since the 1980's there have been reports of arsenic contamination of groundwater throughout Bangladesh. The use of contaminated tubewell water is considered a serious health hazard with one third of the population estimated to be at risk of chronic arsenic poisoning. The exact cause has yet to be established but probable sources are thought to include the use of agrochemicals (some of which contain arsenic), the large quantity of groundwater used for irrigation, and the fall in the Ganges water flow in recent years affecting the underground water level and mobilising naturally occurring arsenic in the aquifer. It is believed that simple education measures may go some way to alleviating the problem by alerting the population to the problem. Other mitigation measures include testing tubewells regularly, preventing the use of contaminated water, and directing people to safe water sources (either safe tubewells or use of surface water or treatment with arsenic filters). In the long term a national water policy is called for to rationalise use of both surface and ground water for both agricultural and domestic use, and to specifically encourage construction of deep tubewells which appear to avoid the problem (Dhaka Community Hospital Trust and Disaster Forum 1997). *See also, groundwater, p51.*

2.5 Injuries

1. Injuries can be sub-divided into intentional and unintentional categories. The unintentional injuries include burns and scalds associated with lack of protection from cookers and heaters. These causes are described, for example, by Hardoy and Satterthwaite (Hardoy and Satterthwaite 1997). Traffic injury is also of great importance, as are physical hazards from house sitting. Improper use or maintenance of agricultural machinery may lead to both acute and chronic injury. *See agricultural labour and its effects on health, p49.* Low standards of safety are commonplace. Unintentional injury appears to account for about 19% of all health problems, peaking in the 2-5 age group.
2. Intentional injuries include homicides, suicides and violence. There is a world-wide epidemic of intentional injury and violent death that is responsible for approximately 10% of the crude death rate among young adult males (Bourbeau 1992). In Latin American cities, homicides are particularly common. The rates tend to be higher among males than females although females are often the victims. Many surveys have found a high prevalence of wife abuse (Heise 1992). For example, 40% of wives in one survey were "beaten regularly". In a study in Papua New Guinea women reported a high rate of beating. The rates were 60% in rural women, 56% in peri-urban women and 62% among urban elite women. Rates in developed countries are similar with about 40% of women surveyed in Texas reporting abuse after age 18. Child abuse is also thought to be a major problem, but data is poor.
3. Rates of suicides and attempted suicides are also high and increasing. There is considerable regional variation with particularly high rates reported in Sri Lanka, Hungary and Finland (Diekstra and Gulbinat 1992). In Sri Lanka and elsewhere drinking pesticides is a common method of suicide (*See agrochemicals, p45*). There are often intra-urban variations in rates of intentional and unintentional violent injury and a linkage with psychosocial disorder. Projects which affect the quality of life of disadvantaged groups in the peri-urban interface may affect the incidence of violent behaviour.

2.6 Malnutrition

1. All agricultural development projects are likely to have an impact on the food security and nutritional status of people living within and outside the project. The impact on nutritional status can be both direct and indirect. Indirect mechanisms include food production, food availability, workload, infection and feeding practices. Under-nourished people are more susceptible to communicable disease. The disease, in turn, may reduce their ability to assimilate whatever food is available. A number of studies have demonstrated an increased risk of death in under-nourished children (Rossi-Espagnet et al. 1991).
2. The effects of under-nutrition include less than average weight or height, blindness, cretinism, anaemia and poor skin condition. Women and children are especially vulnerable because of differential entitlements within the household. Standard measures of under-nourishment are based on weight-for-age, weight-for-height and height-for-age indices. FAO *07ers comm.*) is working on a system of anthropometric measurement for adults to provide an indication of energy under-nutrition. This may be useful as a tool in the study of the rural-urban continuum. It will provide information to supplement the more usual anthropometry that is applied to children.
3. There is plenty of evidence that urban dwellers still depend on self-grown food and access to agricultural land (Hardoy and Satterthwaite 1997). Popkin has suggested that there is a process of nutritional transition that accompanies the processes of demographic and epidemiological transition (Popkin 1996). At its simplest this consists of a change from under-nutrition to over-nutrition. Urban diets are considered to differ broadly from rural diets by showing trends towards:
 - "superior grains" such as rice and wheat rather than corn or millet;
 - more milled and polished grains;
 - food higher in fat;
 - more animal products and sugar;
 - food prepared away from home;
 - more processed food.
4. On the other hand, the diets of the urban and peri-urban poor may be worse than their rural counterparts. There are a number of published examples (Rossi-Espagnet et al. 1991). A study in Thailand demonstrated increased under-nutrition in urban slum children and adults compared with rural communities. Several studies in Latin America have demonstrated that infants that are breast-fed for less than 6 months have a greatly increased risk of dying. Working mothers often have to rely on artificial feeding provided by other child carers so that reduced breast-feeding seems to be a feature of urbanisation. Opportunities for breast-feeding infants in the urban workplace are limited. Some studies suggest that height and weight deficits during the first years of life may frequently be associated with problems in pregnancy that are themselves the result of occupational or other behaviour.
5. Table 14 identifies a series of urban nutritional problems and possible interventions. Many are relevant for natural resource management projects. The report also analysed some of the constraints limiting the interventions.

Table 14 Urban food problems and interventions (From FAO cited by Rossi-Espagnet et al 1991)

Problems	Interventions
Price of food too high	Fair price shops, simpler packaging, communal buying, consumer co-operatives
Price of staples fluctuate at times of scarcity and price in parallel	City food stocks in poor areas
Time shortage for breast-feeding, infant food preparation.	Day-care centres at work places, cheap weaning foods, communal kitchens
Unbalanced food intake, micronutrient deficiency, lack of Household food safe	Urban agriculture, fish ponds, small animal raising, cheap nutrient-dense food mixes
Poor environment, scarce cooking fuel, insufficient drinking-	Piped water at street outlets, urban wood-fuel lots,
Lon distance to markets	Establish controlled and serviced markets in poor areas
Lack of knowledge regarding nutrition	Education programmes
Lade of statistics for planning	Surveys and monitoring
Scarcity of staff for programme implementation	In-service training
Insufficient nutritional aspects within existing community Development programmes	Awareness-raising among decision-makers
Waste of resources and efforts due to lack of programme co-ordination	Establish co-ordinating mechanisms

1. The International Food Policy Research Institute have prepared a draft review of urban challenges to nutrition security (International Food Policy Research Institute 1996). Their primary concern is maternal and childhood

malnutrition. One of the causes of this is believed to be food insecurity. This is dependent on the availability of adequate food and the stability of food; availability and access. Stability is dependent on natural resource management and environmental sustainability. A second cause of childhood malnutrition is believed to be inadequate maternal care such as breast feeding, food preparation and hygiene. The third cause is disease which undermines nutrition and is often a function of environmental health.

2. The review cites literature that indicates that on average infant and child mortality rates and childhood malnutrition rates are lower in urban compared with rural communities. Evidence available suggested that urban diets were more diverse than rural diets and the availability of both energy and micro-nutrients was greater in urban diets. However, childhood morbidity is higher in urban areas in some countries and intra urban differentials are very great. For example, malnutrition rates are much higher in poorer areas and the differences between poor and wealthy areas are larger than urban/rural differences. The review noted the importance of street foods: in some countries 25% of urban household budgets were spent on street foods.
3. The review considers determinants of urban food prices and purchasing patterns. It cites literature indicating that wholesale markets are often run-down, too small and badly managed. Small and scattered retail markets cater to the needs of the urban poor who must make frequent purchases of tiny amounts. The price and availability of food often depends on transport of food to market which depends on the condition of roads, making these an important factor in NR development. Finally, the review identifies a large number of research and policy questions that are relevant to peri-urban research. See also a recent study from peri-urban Accra (Ngleshie-Amanfro Study Team 1996) and other reports including Food and Agriculture Organization (1995) and Hutabarat (1994). The World Health Organization have collected and published a series of papers by Bryan and others on hazard analysis applied to street foods and similar issues (World Health Organization 1993a, Motarjemi et al. 1995; World Health Organization 1996b, World Health Organization, 1996 #608, World Health Organization, 1996 #609).

See also food safety p51.

2.7 Mental disorder or psycho-social disorders

1. Mental disorder has only recently started to receive concerted research attention in relation to urbanisation. The 1993 World Development Report attributed a substantial burden of non-communicable diseases to this source with special emphasis on depression and anxiety in women (World Bank 1993). Rates are about twice as high in women as men and the women who suffer are often victims of violent or alcoholic partners or family members. The economic cost of this burden is unknown but it is clear that it contributes significantly to lost productivity, hospitalisation and early retirement. Other health consequences include violent injury, substance abuse and depression. 'Urbanisation and mental health in developing countries', edited by Harpham and Blue provides the most comprehensive available account of this category of health hazard in the urban context (Harpham and Blue 1995). The following points are relevant to this review.
2. A model of the association between social factors, urbanisation and mental disorder recognises a set of stressors or risk factors including the following (Harpham and Blue 1995; Blue and Harpham 1996).
 - Poor physical environment, including lack of open space, overcrowding, noise,
 - Switch from subsistence to cash cropping
 - Insecure tenure;
 - Women's labour force participation,
 - Under employment;
 - High levels of violence and accidents;
 - Rural-urban migration;
 - Lack of control over events and lack of community support',
 - Negative life events such as unemployment.
3. Numerous studies are cited that associate mental illness with economic status but the association can be in either direction. For example, in USA schizophrenic disorders are more common among poor and depression among wealthy. The evidence is mixed regarding differentials between rural and urban environments as there are many confounding factors. However, urban living is regarded as an important determinant. A chapter by Marsella suggests that an important set of risk factors are life stresses in simultaneous interaction with lack of resources to resolve them. But this is not to imply that only external events are relevant. The vulnerability of individuals is very variable. Many people show remarkable resilience and coping strategies when faced with extreme situations and there are cultural aspects to the expression and resolution of emotion (see chapters by Almeida-Filho et al and Blue et al).
4. There are only two chapters that refer to peri-urban (or suburban) environments. Cheng et al cite evidence from Taiwan that the significant risk factors in the urban environment were finance and employment. The

primary risk factor in rural and suburban environments was physical health. A chapter by Parry proposes a research methodology for mental disorder in the peri-urban environment but does not present results. The topic is new and research is on-going.

- In addition to the evidence presented above, there is anecdotal evidence to suggest that mental disorders increase as a component of 'modern diseases' in the health transition. For example, the ex-mayor of the Colombian city of Cali recounted the history of public health in a peri-urban area. The area was settled illegally during the 1980's and lacked running water and mains sewerage. A program was started to help the people help themselves. By 1994, communicable disease incidence was greatly reduced. However, the incidence of violent crime had increased fivefold, to about 100 per 100,000, and become an important source of death (Guerrero 1996). There are also more analytical studies. For example, an analysis of determinants of maternal mental disorder in Rio de Janeiro suggested that the principle risk factors were: lowest income per capita, bad environmental conditions, partnerless, having more than 3 children. Migration seemed to be of secondary importance (Reichenheim and Harpham 1991).

2.8 Health priorities

- The significance of a health hazard can be assessed objectively or subjectively. For example, irrigation projects in Africa often increase the prevalence rate of schistosomiasis symptoms from less than 10% to more than 50%. Schistosomiasis, or bilharzia, is a communicable disease with symptoms that include blood in stools or urine. In later life, a small percentage of those infected suffer severe disease. The appearance of the blood causes alarm in naive communities but no alarm in communities with prior experience of the disease. The prevalence rate provides an objective measure, the degree of alarm in the community provides a subjective measure. The significance of a health hazard is partly determined by its severity and frequency.
- The costs of ill-health include the costs of health care and treatment, lost production, educational under-achievement, individual suffering and labour substitution. Disability Adjusted Life Years (DALYs), defined in the World Development Report 1993, provide a comparative measure of severity. The relative contribution of communicable diseases, non-communicable diseases (including, *inter alia*, malnutrition and neuropsychiatric disorder) and injury to the burden of ill-health in different regions was illustrated in Figure 1. When disaggregated to take account of urban, peri-urban and rural differences, such data may assist in the identification of priorities.
- Listorti (1996) ranked the top five causes of disease in Sub-Saharan Africa using various data (See Table 15). Together, these diseases contributed about 50% of the total burden. The diseases that are most likely to be influenced by peri-urban NR managers are indicated by shading. Such data is only indicative because there are major differences between communities. Peri-urban areas are most likely to be under-represented because they are informal and poorly served by government health centres.

Table 15 Rank and share of burden of disease in sub-Saharan Africa Listorti 1996a)

Female	Share%	Male	Share
Malaria	11	Injuries	13
Respiratory infections	11	Respiratory infections	11
Diarrhoeal diseases	10	Malaria	11
Childhood cluster	9	Diarrhoeal diseases	10
HIV and other STDs	9	Childhood cluster	10

Listorti reorganised the data to indicate which diseases would be most affected by infrastructure improvements and how. He concluded that 44% of the disease burden would be strongly affected by infrastructure.

Table 16 Infrastructural interventions for common urban diseases in Africa (Listorti 1996)

Disease/condition	Type of infrastructure remedial measure
Respiratory disease	Improved housing and air -pollution abatement
Malaria	Vector control, drainage
Diarrhoeal diseases and worms	Improved drinking water supply and waste management
Childhood cluster	Health care and education
Injuries	Reduction in household and traffic injuries
Tropical cluster	Vector control, sanitation and drainage

Note the tropical cluster includes schistosomiasis and filariasis.

- Not all of the health issues listed above are of equal concern to peri-urban natural resource project managers. In Table 17 we have tried to separate the health hazards into those that are likely to be associated with peri-urban conditions and affected by natural resource management and those which are not. We have also included an intermediate category for hazards that may fit into either.

Table 17 NR managers and non NR managers health concerns

Peri-urban and natural resource associated health hazards	In between	Not peri-urban and/or not natural resource related health hazards
Communicable diseases		
Associated with water: water borne, water related water washed, water contact, including wastewater reuse		Communicable diseases of children preventable by vaccination
Associated with food safe		
Zoonoses associated with domestic animals		Sylvatic zoonoses
Non-communicable diseases		
From agro-chemicals		Poisoning from poorly stored medicines And household chemicals
Heavy metal contamination of food crops or occupational exposure through tannin		Other occupational exposure to heavy Metals
Associated with food safe		
Industrial pollution damaging natural resource base such as fish stocks		Industrial pollution in air which is directly Inhaled
Injuries		
Household burns and scalds from use of biomass fuels		Household burns from electricity
Injury from house sitting	Traffic injury	Occupational injury in non NR industries
Malnutrition		
Associated with lack of access to agricultural land		Malnutrition due to inequalities in Entitlement
Psycho-social disorders		
Associated with overcrowding, lack of open spaces, insecurity of land tenure, and leading to violence, substance abuse, depression	Associated with lack of control of events, noise	Occupational

3. Management 3.1

Summary

- Methods for prospective health impact assessment are described. The preferred method is based on community risk factors, environmental risk factors and institutional risk factors.
- The completion of a summary health assessment table, such as Table 18, is advocated.
- Opportunities for health risk management in development projects are outlined.

TABLE 1 S Summary health assessment table

Health hazard	Community ' groups	Community risk factors,	Environmental risk factors	Institutional risk factors	Change in. health risk attributable to the project
Communicable diseases					
Non-communicable diseases					
Injury					
Malnutrition					
Mental disorders					

3.2 Health impact assessment

1. Health impact assessment is a management tool. It consists of three general steps that are common to many management problems. Within the health sector similar steps are encountered in both food and occupational safety studies. The three steps are:
 - identification of health hazards,
 - assessment of health risks,
 - implementation of health safeguards and mitigation measures.
2. Identification of health hazards requires detailed reviews of known issues. This forms the bulk of the report. The assessment determines whether the health hazards identified may lead to changes in health risks associated with a project. The assessment should be prospective: it should indicate the future changes that are expected (Birley 1991; Birley 1995).
3. The health risk assessment process consists of an examination of the component risk factors. These have no unique designations. The following new designations are proposed.
 - Community risk factors - the socio-economic and physiological risk factors that determine the vulnerability of specific community groups to specific hazards and which depend on physiology, education, behaviour and poverty and other forms of vulnerability. The community groups, or stakeholders, associated with the project must be identified.
 - Environment risk factors - bio-physical and social environment risk factors that determine the exposure of communities to health hazards and which depend on vectors, poisons, machinery, food supply, alienation, unemployment, violence and stress.
 - Institutional risk factors that determine the capacity, capability and jurisdiction of responsible services to protect the communities from the hazards.

3.2.1 Community risk factors

1. These factors are characteristics of the vulnerable human community. The factors include poverty, immunity, education and occupation. Other determinants include individual or household ability to afford health care, make appropriate emergency responses, take time off to recover from illness or injury, to rearrange household activities and having a support network to draw on (Hardoy and Satterthwaite 1997). Social roles, including occupation, may determine the duration and severity of exposure to hazards (Satterthwaite 1993). Movement from rural environments is also associated with a range of lifestyle changes which are linked to a variety of urban health problems (Rossi-Espagnet et al. 1991). The particular environmental and community risks for children are reviewed by Satterthwaite et al (1996).
2. A similar system of community risk factors was used in British Columbia to assess the impact of public policies and projects on health (Frankish et al. 1996). The risk factors considered were: income and social status; social support networks; education; employment and working conditions; biological and genetic endowment; personal health practices and coping skills, healthy child development.
3. Gender differences are frequently an important determinant of vulnerability. Survival strategies of poor women in urban Africa are described by O'Reilly and Gordon (1995). A recent anthology explores the linkages between gender, health and environment (Sims 1994). A paper by Oruwari, cited by Sims, examined housing needs in poor communities in Port Harcourt. The survey revealed that women funded 55% of household expenditure through their own micro-enterprises, usually retailing foods. The paper discusses how the associated stresses may undermine women's health. An associated theme was the inappropriate allocation of housing to male rather than female household heads. Other papers cited by Sims are concerned with domestic energy and indoor air pollution and occupational hazards. The report reviews the complex relationship between domestic energy shortage and women's health. For example, there are references to pneumoconiosis in women caused by a combination of biomass fuel smoke and maize grinding; and lung cancer in Chinese women from a combination of passive smoking and poor quality coal use.
4. A section on occupational hazards reported a number of comparisons between male and female workers and between exposed and unexposed groups. Of particular interest was a study by Restrepo et al, cited by Sims, on pesticide exposure among female floriculturalists in Bogata. Large numbers of pesticides were being used in the flower growing industry. The study detected significant differences in foetal loss, prematurity and congenital malformation among women according to their exposure. A study by Ferrar reported on hydrogen cyanide exposure among women working in the cassava processing industry. No results were reported, but a simple indicator test-paper had been developed which could be used by women to monitor their exposure to this dangerous gas.

5. Definition of community groups by less obvious factors than gender and age may be difficult in peri-urban areas. People dwelling there may have a weak sense of their own community as a result of mobility and breakdown of traditional family ties, changing gender roles and ethnic diversity. New definitions of community may be emerging based on common perceived hazards.
6. In general, a number of diverse communities can be identified but there will rarely be sufficient demographic data to determine the size of each group.

3.2.2 Environmental risk factors

1. These include the bio-physical and social environments in which the community are exposed to the hazard. The bio-physical environment includes access to infrastructure such as water supply and sanitation as well as the natural environment. Access to the physical requirements for good health is strongly skewed within the urban and peri-urban environment. For example, the richest 20% of the urban community may consume 80% of the public services such as water supplies (Hardoy and Satterthwaite 1997).
2. A natural resource development project may promote a succession of plant and animal communities including disease vectors (e.g. mosquitoes and snails), animal reservoirs of disease (e.g. rodents and pigs) and agricultural pests and weeds. For example, mosquitoes may breed in seepage pools associated with water resource development.
3. There are problems of contamination of water supplies with human faeces, inadequate sanitation, drainage and solid waste disposal. Chemical pollutants are transported through water, soil and air. Geographical factors which can affect risk include topography and zonation. In the working environment, injury is caused by fast moving machinery and poisoning by exposure to hazardous substances. Noise is a common problem of both the work and domestic environment. In general, the external environmental risk factors can be categorised as focal or dispersed, frequent or infrequent, near or distant.
4. Risk or industrial hazard assessment is a component of health assessment that focuses almost exclusively on the environmental factors. It often involves an engineering analysis of the concentration of an unintended release of energy or chemical at various distances from a point source and the probability of that release occurring. Environmental impact assessment (EIA) also generally focuses on the external environment and pays little attention to host risk factors.

3.2.3 Institutional risk factors

1. Protection of human health is the responsibility of many agencies in addition to the Ministry of Health. For example, The Ministry of Labour or Employment oversees occupational health and safety; Public Works control drinking water quality and sanitation; Transport controls traffic movement and safety; Agriculture controls access to communal and forest lands, irrigation water and agro-chemicals. The division of responsibility between project proponents and local government is often not clear. Local government may lack the capacity to discharge their responsibilities. Health activities are also undertaken by a range of non-governmental organizations and the private sector is often an important source of health care.
2. The assessment should determine whether these agencies have the capacity, capability and jurisdiction to prevent exposure of the vulnerable community to the identified health hazards or to care for them after they are exposed. This is akin to the institutional analysis undertaken in social impact assessment. **Capacity** refers to resources in terms of staff; equipment, communications and transport. Capability refers to the skills of the staff to use their resources. For example, a health centre may not be able to cope with an influx of 30,000 immigrants without additional staff, infrastructure, drug supplies, environmental and health education officers, primary health care facilities and mosquito control. If the project creates new or unusual health risks the staff will need additional training on how best to respond. The assessment should determine whether a multi-sectoral approach is taken towards planning. For example, are there any formal or informal linkages between the Ministry of Health and the project proponent? **Jurisdiction** refers to the limits of responsibility of each agency. Urban services each define their own boundaries and jurisdictions and these may be poorly defined, overlap or have gaps (Silimperi 1995). This makes it difficult for urban citizens to mobilise needed services or to obtain maximal assistance. Informal and peri-urban communities are frequently perceived as having no legitimate rights to urban services.

3. In the system used in British Columbia the importance of assessing the "policy environment" was also stressed (Frankish et al. 19%). The intention was to find indicators that measured the very presence of a healthy public policy. The process consisted of
 - the identification of social organisations and institutions engaged in policy-making;
 - the identification of policy-making processes and outcomes,
 - a description of policy directions;
 - analysis of past, present and future trends.
4. This process provides an opportunity to identify health protection agencies and to consider their past, present and future capacity, capability and jurisdiction.
5. The role of institutional factors in the improvement of household environments is discussed by McGranahan (1992).

3.2.4 Completing the assessment

1. The analysis seeks to gather information under the headings discussed above. The results can then be summarised in a matrix, such as Table 18. This matrix provides a useful summary of the assessment for readers who do not wish to examine the details. It should be supported by summary paragraphs and these, in turn, should be supported by detailed evidence.
2. The evidence gathered will vary considerably in quality. A recent health assessment separated evidence into four classes, as follows (Will et al. 1994).
 - Calculable - strong, easily quantifiable relationships that can be precisely calculated such as relative risk.
 - Estimable - strong relationships where impact can be estimated in percentage or rank terms.
 - Definite but not measurable - relationships that can be described but not measured.
 - Speculative - observed or theoretical relationships which are at present unproven or for which the biological mechanism is unclear.
3. A different approach to evidence was used in a method referred to as comparative risk assessment (Brantly et al. 1997). The method distinguished different levels of reliability in the evidence and sought to determine whether a potential environmental health problem was significant. If both the environmental cause and the public health outcome were documented then the evidence was considered to be good. But if only one or the other were documented, the risk might exist but the conclusion could be reached with less confidence. See *also comparative risk assesment p51*.

3.3 Implementation

1. The third and final component of the management process consists of the implementation of health safeguards and mitigation measures. These are sometimes referred to as health risk management (Birley 1995). Affordable solutions are frequently available. Programmes often fail because of weak government implementation capacity, market imperfections and lack of inter-sectoral collaboration. In this section we focus on safeguarding health in NR development projects.
2. Health risk management is first and foremost about prevention and about seeking opportunities within the project to safeguard and enhance human health. It is not simply about providing extra services such as health care, health education and more medicine. In many cases, modification to project plans and operating or maintenance procedures will simultaneously improve the efficiency and sustainability of the project and safeguard human health. Box 8 provides examples of environmental management measures that have been used effectively to control vector-borne diseases

Box 8 Examples of environmental measures for the control of vector-borne disease

Malaria and yellow fever control were essential for the success of the Panama canal project at the beginning of the 20th century. Control was achieved by simple drainage, filling and screening measures. At the same time, subsurface drains helped control malaria in Malaysian plantations. More recently, manipulation of reservoir levels has been instrumental in controlling malaria in America, while spillway redesign has helped control the blackfly vector of river blindness in Africa, drain improvements have helped control urban filariasis in India and house inspection has helped control dengue fever in Singapore.

1. There are many health risk management measures and they can be grouped according to whether they place responsibility with the individual or the society. In many cases a societal component is required to balance that of the individual. For example, avoidance of traffic injury is not only the responsibility of the driver; the need for safer vehicles is widely accepted. Shortage of resources in developing countries sometimes dictates a transfer of responsibility from society to the individual: malaria control has shifted from mass spraying to

individual use of bednets- single disease control programmes have been replaced by horizontal approaches that depend on the support and empowerment of local communities. Passive measures that do not require the active and continued co-operation of the community have to be included in project designs. Examples include infrastructure that prevents the accumulation of waste water and contact with contaminated water, traffic regulators, pollutant emission controls and new agro-chemical formulations.

2. Risk management techniques employed at societal level include the following, in order of priority.
 - Avoiding or eliminating the risk by prohibiting the use of a substance or activity, such as control of agro-chemical imports,
 - Regulating the use so as to reduce adverse health effects, such as by zonation;
 - Reducing vulnerability of people by using personal protective devices, such as helmets, masks and boots,
 - Developing mitigation and recovery procedures after the event, such as medical centres and emergency services;
 - Instituting schemes to reimburse and redistribute losses, such as insurance.

3. In order to be effective, health risk management measures must also be socially acceptable to the community, reasonably costed and of proven efficacy. The agencies responsible for implementation must be specified and the capacity, capability and jurisdiction of these agencies must be sufficient to undertake the task. The communities own perception of health risk is likely to be different from, and more important than, that of the outside observer. For, example, a study of slum dwellers in India identified flooding as a primary concern (World Resources Institute 1996). Action taken by the municipal government to control flooding included installation of covered drains. Paradoxically, this increased the risk as the community could no longer monitor the water level and have warning of potential flooding.

4. The emphasis should be on health opportunities and not only impacts. Each project can strengthen and be strengthened by the incorporation of measures that contribute positively to human health.

4. Energy efficiency 4.1

Summary

Table 19 Summary of health linkages for energy use

Development sub category	Communicable diseases	Non-communicable Diseases	Malnutrition	Injury
Biomass fuels	indoor air	indoor air pollution	petroleum	occupational injury dust collection and
Fossil fuels		indoor and outdoor air pollution		occupational,
Water reservoirs	vector breeding water pollution			
Power lines		potential proximity risk	cancer	

- Indoor air pollution from burning biomass fuels is an important cause of respiratory illness, heart disease, eye disorders and low birth weight.
- Little is known about the occupational health problems of workers using biomass fuels in cottage industries.
- Burns and scalds are a hazard of using poorly designed cooking stoves.
 - Muscular and skeletal industries are associated with long distance portorage of fuelwood. ?
- Malnutrition is associated with loss of land from subsistence crops to fuel crops.
- Fossil fuels are responsible for much ambient air pollution.
- Hydropower reservoirs promote vector-borne disease transmission, pollute downstream drinking water and may disrupt fish stocks.
 - There is concern about the risk of cancer and other diseases from powerlines. The level of risk is still unclear.

4.2 Introduction

1. Provision of energy has many direct and indirect benefits to health. For example, electricity is used in refrigeration of food and medical supplies including vaccines and fossil fuel is used in fertiliser manufacture to enable increased food production. There are several major reviews of the negative health impacts of the energy sector (World Health Organization 1983; Cooper Weil et al. 1990; World Health Organization

Commission on Health and Environment 1992a; Smith 1993). The following four priority areas were identified.

- ❑ indoor air pollution from biomass and coal combustion - respiratory diseases associated with air pollution have become as important as diarrhoeal diseases as major sources of morbidity and mortality; J Exposure of large urban populations to high levels of ambient air pollution,
- ❑ Serious injuries associated with extraction, storage and power generation;
- ❑ Global climate change (outside the scope of this review).

2. Respiratory ailments are strongly associated with fuel use and energy efficiency. An energy ladder is recognised in which cheaper fuels are more polluting. As income increases people tend to move up the energy ladder. However, there is a time lag as they tend to continue to use the same cooking fuels as when they were poorer.
3. Research on fuel efficiency has not always aimed to reduce pollution. In the period 1984-94, some 1.3% of spending in sub-Saharan Africa was devoted to improving efficiency of cooking stoves but it was done for ecological not health reasons (Listorti 1996a). There is a widespread agreement that a more integrated approach is required that considers improvements in kitchen conditions more generally and this should include indoor air pollution as well as stove improvement.
4. There are a number of linkages between fuel and food preparation. Food vendors may extend their cooking times and hence their exposure to air pollutants. Working women may shorten their cooking time, producing undercooked foods that are less safe.
5. NRI commissioned a review of energy utilisation in peri-urban production systems (ETSU 1996). The following points from that review are pertinent.
 - Energy expenditure occupies a prominent place in poor households and the poorest household tend to spend a higher proportion of income on energy. For example, in Kenya very low income communities spent 30% of their income on food and 10-30% on fuel.
 - Woodfuel is a preferred source of energy for a range of social and dietary reasons.
 - Households under energy stress employ a range of management strategies which affect their nutrition and food safety.
 - Energy transitions are not unidirectional and under economic pressures or fuel shortages people may revert from commercial back to traditional fuels. Fuel use can show seasonal variation. Purchased fuel is supplemented with gathered fuel. The energy transition can be represented by two crossing histograms, similar to the health transition: traditional energy sources decline and modern energy sources increase in the transition from more rural to more urban.
 - Different fuels are not equally useful for the same purposes. For example wood stoves may focus heat more effectively on cooking pots than kerosene stoves.
 - Women dominate household energy collection, production and use in the peri-urban environment but gender issues have received little attention.
 - An increasing percentage of time available is spent on fuel gathering because of increasing scarcity.
 - Transportation systems for moving fuels from the rural fringe to the urban fringe are sometimes poorly developed. A transport transition model was proposed similar to the energy and health transitions.

4.3 Biomass fuels

4.3.1 Introduction

1. Biomass fuels are the primary fuel for most domestic users in poor communities. They include wood, logging wastes, animal dung and crop residues. Wood for fuel is one of the safest crops to grow with wastewater because it minimises the danger of contamination with pathogens or hazardous chemicals. However, there are important health hazards associated with the collection and burning of biomass (World Health Organization 1992). These include the respiratory disease caused by smoke and the eye disease caused by intense heat as well as smoke. One solution is to improve cooking stoves and kitchens to reduce indoor air pollution. WHO set an agenda for this purpose which included epidemiological research, dissemination and social studies, but little of this agenda has been completed (Dr Nigel Bruce and other key informants, *pers. comm.*).
2. Work on improving biomass stoves has been on-going for many years primarily for environmental and economic reasons. In recent years more attention has been placed on health but few studies have been funded. Improved cooking stoves may reduce particulate concentrations by 50% but they are still substantially higher than commonly acceptable levels (Bruce, *pers. comm.*). Acceptable levels may be reachable with well-made, installed and maintained stoves. But there is insufficient research-based evidence.

The levels of PM₁₀ around open fires are >1000 ug/m³. Improved stoves may reduce this to 500 or even 80-150 following careful installation. Morbidity effects may still be detectable at levels of 30-50ug/m³

3. A recent research proposal (Dr Bruce, pers. *comm.*) seeks to establish a resource centre and to promote better links between natural resource and health researchers. It identifies priorities in health and implementation research. Key health research issues are:
 - obtaining more robust evidence of the causal association between indoor air pollution and pneumonia in young children and low birth weight;
 - quantifying the effect on key child and adult health outcomes of reducing exposures across the range of achievable exposure levels;
 - developing simple, inexpensive, and valid measures that can be used to assess health impacts of different exposure levels.

4. Key implementation research issues are:

- assessing applicability of measures to assess health impacts of exposure in a range of settings; J further research on emissions and fuel efficiency of interventions;
- evaluating integrated community-based approaches to improving kitchen environments.

5. A key informant at FAO suggested that in addition to domestic air pollution, relatively little work has been done on the occupational health and safety of workers in cottage industries, other industries, and institutions that use biomass fuels. Industrial examples include brickmakers and ceramic factories while institutions include schools and hospitals. The Intermediate Technology Development Group also has an active interest in cooking stoves and indoor air pollution. An unpublished review discusses the relative costs and benefits of chimneys versus hoods and summarises their own work in this field (ITDG unpubl). They do not appear to have a peri-urban focus at present.

4.3.2 Communicable diseases

Presence of indoor air pollution from biomass fuels is a risk factor for acute respiratory infection (ARI) in children. For example, baby girls in the Gambia that are carried on their mother's back during cooking were found to have six times higher risk of ARI (cited in WHO, 1992). The World Bank attributed 50% of the burden of disease in poor countries to indoor air pollution (World Bank 1993). Most of this was through acute respiratory disease in children and chronic obstructive lung disease in adults.

4.3.3 Non-communicable diseases

- Exposure to smoke causes respiratory and eye irritation and associated diseases such as:
 - 7 Chronic obstructive lung disease;
- Heart disease, especially cor pulmonale which is secondary to lung disease,
- Low birth weight due to maternal exposure which is associated with a range of perinatal and infant ill-health;
- Eye disorders: conjunctivitis, blindness;
- Cancers: lung cancer due to long term exposure to smoke (Mutere 1991; Smith 1991 a).

1. Women and infants are the most vulnerable groups. Household cooking on an open fire has been described as the largest single occupational health problem of women in the world (Smith 1987; World Health Organization Commission on Health and Environment 1992a). Measurements in the kitchens of Indian villagers found particulate levels 100 times above recommended standards (Leitmann 1991). They also found levels of a carcinogen equivalent to smoking several packets of cigarettes per day. A study in Nepal in 1986 indicated that improved cooking-stoves were effective in reducing the cook's exposure to health damaging particulates by approximately two thirds. They also reduced carbon monoxide concentrations in kitchens by three-quarters in comparison to neighbouring kitchens with traditional cooking- stoves (Mutere 1990). A recent study from India observed better lung function in women using fuels other than biomass fuels (Dutt et al. 1996).
2. Urban (and peri-urban) poverty may reinforce exposure to pollution at the household level. A study in Rio suggested that the poor do not have access to less polluting technologies (Leitmann 1991). The poor may pay far more for fuel than the more wealthy. They also live in areas more affected by industrial or traffic pollution. The total pollutant emissions from one large remote fossil fuelled power station may be less than the pollution from a large number of small wood burning plants (Leitmann 1991).

4.3.4 Injury

1. Biomass stoves are often at floor level causing injuries, especially burns to children, and jeopardising trod hygiene (World Health Organization Commission on Health and Environment 1992x; Listorti 1996a).
2. Fuelwood often has to be transported long distances on heads and backs promoting occupational injury. For example, between 1966 and 1981 the distance travelled in northern Uganda to find fuelwood increased from an average of 0.9km to 4.4km (Hamilton 1984). Women are specially vulnerable.

4.3.5 Malnutrition

1. Petroleum substitute fuels are produced by the fermentation of food crops such as sugar cane, cassava, corn and sweet sorghum. Sugar cane is the most efficient in terms of net energy yield. The large scale use of such crops to produce fuel could seriously deplete the food supply in local communities. Even crop residues could be more valuable to local farmers as a soil conditioner than fuel produced from the residues. Removal of large quantities of biomass from a given locality will produce changes in soil, forestation, groundwater recharge, surface runoff and aquatic biota that could adversely affect the productivity of fisheries and farms (Lee 1985; Leitmann 1991). This degradation casts an "urban shadow" over the peri-urban areas, especially along transportation routes (Leitmann 1991). However, a Zambian study suggested that only 12% of woodland clearing could be attributed to woodfuel, the majority was converted for cropland.
2. A study in India suggested that the energy cost of collecting fuelwood, water and other domestic chores represented on third of a woman's daily energy expenditure (Cooper Weil et al. 1990). In several African cities, poor families have to spend 20-30% of their income on charcoal, reducing the sum available for food purchase (Harrison 1987).

4.4 Fossil fuels

Coal is promoted as a household fuel to reduce the effects of deforestation. But coal tends to produce more air pollution.

4.4.1 Non-communicable disease

1. Fossil fuels (coal, gas, and oil) account for most of the global industrial energy sources. The health hazards of fossil fuel use can be classified according to time of onset of the potential illness or disability or according to the stage in the fossil fuel cycle. The long term mutagenic and carcinogenic effects are the most serious and most uncertain.
2. The pollutants emitted by the combustion of fossil fuels have an impact on the health of nearby communities and are also dispersed over large areas. They include sulphur dioxide, nitrogen dioxide, carbon monoxide, particulate matter, ash and carbon dioxide. Carbon monoxide accumulates in buildings when combustion chambers and exhaust ducts are not properly sealed. It impedes oxygen transport in the human body leading to neurological, physiological and cardiovascular impairment. Nitrogen dioxide impedes respiration. Oxides of nitrogen react with hydrocarbons to produce photochemical smog that causes eye irritation and acute respiratory disease. In London, 1952, when the atmospheric concentration of sulphur dioxide and suspended particles exceeded 1000 ug/m³ the total daily mortality rate doubled. Similar effects have been reported from Japan (World Health Organization 1979b). A rapid increase in upper respiratory infection was reported in the vicinity of a new coal-fired power station at Batangaas, Philippines (Environmental Management Bureau (Philippines) 1990). In China, burning high fluoride content coals contributes to endemic fluorosis affecting large populations (PEPAS 1991).
3. High concentrations of sulphur dioxide and particulates increase respiratory disease and can increase mortality. Hydrogen sulphide exposure is an occupational hazard and in high concentrations causes acute intoxication and eye ailments (World Health Organization 1981). In Mexico, 1950, an oilfield flare malfunctioned releasing hydrogen sulphide; 320 people were hospitalised and 22 died (World Health Organization 1981).
4. The relative health risks of coal- versus oil- based electricity generation are complex. The occupational risks of deep coal mining are well established and include injuries and respiratory disease. The by-products of coal and oil processing include chemicals that can cause skin tumours and dermatitis. The ash residue from coal burning contains concentrated toxins such as heavy metals. The emissions from coal-fired plants are harder to contain than those from oil-fired power stations. Small to medium sized power stations are more dangerous to the immediate population than large ones because they have lower stacks.
5. The emissions from petrol or diesel engines are an important source of air-borne pollutants and contribute to photochemical smog. Urban air pollution from burning fossil fuels regularly exceeds the health-related guidelines established by WHO in over half of the cities that are monitored (World Health Organization Commission on Health and Environment 1992a). Burning domestic fuel generates about half of Delhi's air

pollution, according to one estimate. Some cities in Central and Southern Africa suffer from thermal inversion smogs made worse by the extensive use of wood and coal for domestic purposes. In Southern Africa this is associated with the spread of tuberculosis and other respiratory diseases (Meakins 1981).

4.4.2 Injury

Noise and vibration are occupational hazards of power plants that affect general well-being, hearing and vision. The transportation of fuel by road and rail increases the risk of traffic crashes and collisions. Fires and explosions are hazards of fuel combustion in power stations. Burns and scalds may occur at various stages of the process. Gas pipeline explosions killed 508 people in Sao Paulo, Brazil in 1984 and 58 people in Mexico in 1978 (Covello and Frey 1990). Gas released in a tank explosion in Mexico in 1984, left 452 dead, over 4,000 injured, and 300,000 required to be evacuated (LaDou 1992).

4.5 Water reservoirs

Reservoirs constructed in peri-urban areas are likely to be for domestic water supply rather than hydropower generation, although both are possible. There are important health hazards associated with the large bodies of water that are stored, diverted and discharged during dam construction and operation. Land use changes occur and many people are resettled, with health consequences. *See labour mobility and resettlement, p51*. Large construction projects such as dams entail occupational injury, while drowning of children can be a cause for concern when the reservoir fills.

4.5.1 Communicable disease

1. The communicable diseases most often associated with reservoirs are malaria, schistosomiasis and onchocerciasis. Large engineering projects involving rivers have frequently led to explosive malaria epidemics during construction. The main cause is the increase in water-filled excavations and diversions. Erratic downstream flows promote stream pool breeding of mosquito vectors while spillways, in some regions, support breeding of black fly vectors of river blindness. The natural flow in the upper reaches of the Mahaweli river, Sri Lanka, was interrupted by dams and diversions. Stream pools formed in the dry river-bed in which malaria vectors bred. A reservoir of infection was created by human circulation between lowland resettlement sites and riverine villages (Wyesundera 1988).
2. Mosquitoes which transmit malaria often breed in the shallow, sheltered margins of reservoirs (Ripen and Raccurt 1987). However, there is much variation between regions. In Africa, malaria mosquito breeding is also associated with drawdown that exposes numerous puddles on gently sloping shores. In Asia, downstream pools in the river bed tend to be more important. A small dam was built to regulate flow to the Edea hydroelectric plant in Cameroon. The shallow waters contain abundant vegetation and larvae of the mosquito *Anopheles funestus*. The prevalence of falciparum malaria was high in surrounding villages and decreases with distance from the lake (Ripert and Raccurt 1987).
3. Schistosomiasis and, to a lesser extent, dracunculiasis are commonly reported hazards of reservoir construction. The large reservoirs usually associated with hydropower have many sheltered, shallow inlets where aquatic vegetation thrives. Informal settlements of fishers are frequently a vulnerable group. An increase in schistosomiasis has been observed across most of SSA where water development has taken place. The increases in prevalence have often been dramatic and the intense haematuria in children has caused public alarm (Hunter et al. 1982). Urinary schistosomiasis was locally of low prevalence before the Akosombo Dam was built in Ghana. The reservoir attracted some 150,000 lakeside residents and there was an explosive increase in prevalence. Prevalence rates fell rapidly with distance from the lake shore due to decreasing dependence of the lake for water needs (Hunter et al. 1982). By contrast, in Asia schistosomiasis is contained within small endemic foci and dam development has often proceeded without outbreaks of the disease.
4. In South-east Asia and countries of the former USSR *Opisthorchis* infection (human liver fluke) is associated with reservoir construction (World Health Organization Commission on Health and Environment 1992a).
5. Reservoir outflow is often polluted by decomposing plant material. Pollution reduces access to potable water for downstream communities that rely on the river, promoting transmission of waterborne diseases. Reduced stream flows alter the replenishment rate of aquifers, affecting domestic water supply, and promoting saline intrusion on to irrigated lands. Reduced nutrient flows disrupt fisheries and reduce food security. Groundwater rose in Lower Egypt as a result of the Aswan Dam. Wastewater disposal was disrupted and aquifers became polluted (Egboka et al. 1989).

4.6 Power lines

There is current concern about the effects of electromagnetic radiation from high tension power lines, but little conclusive information. Exposure to electromagnetic fields may increase the risk of some cancers, in

particular leukaemia, lymphoma and nervous system tumours (World Health Organization Commission on Health and Environment 1992x).

5. Crop production intensification

5.1 Summary

Table 20 Summary of health linkages for crop production

Development Sub-category	Communicable diseases	Non-communicable diseases	Malnutrition	Injury
Urban and peri-urban agriculture	Animal husbandry, vector breeding sites	Agro-chemicals	Increased food supply	
Choice of crop	Vector breeding sites	Agro-chemicals, plant poisons, bio-accumulation of poisons	loss of subsistence, inappropriate crops	
Agricultural labour			" Loss of subsistence crops "	>Posture and heavy labour and carrying
Mechanisation	Loss of alternative hosts for vectors	Noise	Loss of income	Heavy and fast moving machinery
Agricultural processing industries		dust and mould induced lung disease, eye and skin irritation "		

- ❑ The most direct link between peri-urban agriculture and health is via nutrition. Promotion of subsistence crops is likely to benefit the nutritional status of the poorest people.
- ❑ Agricultural intensification, especially of cash crops, introduces health hazards such as poisoning from agro-chemicals, injuries from machinery, posture and physical demands and communicable diseases associated with surface water.
- ❑ Changing labour practices can lead to loss of livelihood, subsistence crops and within-household entitlements to food and hence malnutrition.
- ❑ Changing labour practices can reduce time available for child care including cooking, feeding and social interaction and hence childhood malnutrition, infection and injury-
- ❑ Peri-urban agriculture often uses hazardous waste products that contain pathogens and poisons that affect occupational safety.
- ❑ Food crops may be contaminated by chemical uptake from air, water or soil media that affect consumers. Pesticides are often misused and there is scope for reducing their use.
- ❑ There are uncertainties about the effectiveness of post-harvest decontamination of food crops by washing, cooking or other treatment. Post harvest processes can themselves be hazardous.
- ❑ The waste products from agriculture can be hazardous, contaminating air, soil and water media.

5.2 Introduction

1. An extensive review of agriculture-health linkages identified four components of agriculture in which health impacts can occur (Lipton and de Kadt 1988)
 - ❑ inputs, such as land, water, agro-chemicals, draught power and labour;
 - ❑ technologies (hydraulic, mechanical, biological and post-harvest),
 - ❑ structures of work and ownership (including assets, customs and laws),
 - ❑ outputs (such as choice of crop, food safety).
2. The agricultural-nutrition chain constitutes the main set of links between agriculture and health. The objective of agriculture ultimately is not production but improved nutrition. Agricultural projects in urban areas can be major determinants of food intake, energy requirements for work, and susceptibility to some infectious diseases. Children's health is particularly affected by the interaction of malnutrition and infection. Healthier farmers and workers may be more productive and more careful. Yet health considerations play little or no part in most decisions either by farmers about production or by government about agricultural policies.
3. Future increases in agricultural production will mainly come from further intensification of agricultural production on land that is already devoted to crops and livestock. This intensification could cause adverse environmental changes such as water logging, salinisation and ground water contamination, which have associated health impacts.

4 The agricultural changes that affect health can be grouped into three categories (Rattan 1994).

- ❑ Changes in specific agricultural techniques are likely to have a single main health effect. An example is the introduction of a new piece of machinery, a new fertiliser or pesticide. The consequences include occupational injury and poisoning. Work related injury is a particular area needing more analysis. These events can be monitored using survey techniques.
- ❑ Changes in farming systems are likely to have many complex and indirect health effects. An example is a shift from subsistence to cash crops. The impact may be non-specific by increasing or reducing the distribution of disposable income (Cooper Well et al. 1990). There may be increased incidence of pre-existing local diseases.
- ❑ Changes in land and water resource use are likely to affect vector-borne diseases. Examples include the creation of irrigation projects and deforestation for agriculture. Land use changes may alter the breeding sites for vectors of malaria, schistosomiasis, Japanese encephalitis, sleeping sickness and leishmaniasis.

5.3 Urban agriculture

1. Various estimates suggest that 25-100% of urban food demand is met through urban horticulture, aquaculture and livestock production. Of particular importance are perishable foods which benefit from short transportation and storage times between harvest and market. Urban and peri-urban agriculture includes both formal and informal scales of production and diverse locations. Between 25% and 80% of urban families may be engaged in some form of urban agriculture. The majority of farmers practising urban agriculture are poor and farming on land which they do not own. Urban agriculture is considered to be a contributor to sustainable development, providing an economic method of recycling urban solid waste and domestic waste water. Urban agriculture also has a role to play in the improvement of living conditions in urban slums. It converts derelict land to productive use and provides an incentive to collect and reuse organic wastes as fertiliser or irrigation water. It may also provide the incentives for infrastructure development.
2. Many international organizations have urban agriculture programmes including DFID, USAID, IDRC, GTZ, the World Bank and many NGO's. For example, IDRC have a strong interest in urban agriculture through the Cities Feeding People programme. One current project is assessing peri-urban agricultural production on available land and co-ordination with reuse of waste in Santiago de los Caballeros in the Dominican Republic (Pontificia Universidad Catolica Madre Y Maestra 1996).
3. The special problems of urban agriculture include the following.
 - ❑ Lack of policies and regulation, or inadequate institutional frameworks, means most cities do not manage - urban agriculture activities to ensure environmental protection, health and safety.
 - ❑ There is limited access to agricultural inputs such as wastewater, solid waste and land.
 - ❑ Political and socio-cultural biases mean that planners view urban agriculture as an inappropriate activity to take place in cities and it is often banned.
4. Urban agriculture is being vigorously promoted at present through the activities of the urban agriculture network and elsewhere (Smit et al. 1996). For the purposes of this review no distinction need be made between peri-urban and urban agriculture. The benefits and disbenefits of urban agriculture are only relevant to this review in so far as they have either a direct or indirect linkage to human health. Some of the negative health linkages listed by Smit (1996), are as follows.
 - Malaria associated with cereal crops (but see below).
 - Infections caused by contaminated food sold in unregulated markets.
 - Tuberculosis from cattle.
 - Trichinosis and swine flu from pigs.
 - Compost attracting rats which may be reservoirs of diseases such as plague.
 - Hepatitis and heavy metal poisoning from fish.
 - Heavy metal and other poisoning from vegetables grown close to industries.
 - Insecticide poisoning from intensive use on vegetables.
 - Water pollution from animal remains.
 - Infection and pollution from informal slaughtering.
 - Agricultural waste and chemicals polluting water supplies and soils.
 - Insecticidal sprays causing air pollution.
 - Planting on roadsides increasing traffic accidents.
 - Wandering domestic animals increasing traffic accidents.
5. Many of these health concerns are discussed elsewhere in this review. As Smit suggests, once they are identified, appropriate solutions can be sought. Many of these hazards carry a similar risk in both rural and

urban environments. The list above is clearly incomplete and it should be noted that there are in any other zoonoses and vector-borne diseases associated with a range of crops. *See also vector borne diseases, p16 and zoonoses, p23 and p51.* Overall, the potential negative health impacts of urban agriculture seem to have received little attention among its promoters.

6. In many parts of Africa the production of cereals such as maize has been prohibited in cities for many decades because of an irrational fear that the plants breed malaria mosquitoes, *but see Box 9.* A more recent reason for prohibition is that tall crops provide hiding places for criminals. Intentional violence and criminal behaviour may be regarded as a public health issue and an analysis of the benefits of crop destruction versus crop promotion in changing the prevalence of criminal behaviour would be instructive. In SSA, malaria is considered a rural problem but it occurs in towns and cities where pockets of countryside are incorporated through urban agriculture. During the dry season many towns and cities practice irrigated agriculture. As detailed elsewhere in this review, agricultural practices which require the diversion and storage of surface water can promote the breeding of mosquitoes and disease transmission. *See vector borne diseases, p16* Whether or not the associated surface waters are suitable for malaria vector breeding will depend on their cleanliness. Frequently such water may be too polluted. This is a serious issue and it can be prevented by environmental management. The urban agricultural proponents need to be informed about appropriate environmental management.

Box 9 Urban agriculture in Harare

An ODA funded study of urban agriculture in Harare contains a number of observations related to health impact (Bowyer-Bower and Drakakis-Smith 1996). Two kinds of cultivation were investigated: home gardens with leafy vegetables and tomatoes, and illegal plots on public land with maize and groundnuts. The main concern of the study was the effect of cultivation on soil and biodiversity loss. Field measurements indicated a reduced rainfall infiltration rate of 28% and increased surface runoff of 3.5 times, leading to increased flooding and reduced groundwater recharge. The large surface flows and rainfall impacting on bare soil produced considerable soil movement which blocked surface and underground drains. During the dry season there was an increase in windborne soil. A range of pesticides and fertilisers were used in the cultivation. Crops produced were consumed by cultivators or marketed.

Communicable disease

There were no references to communicable diseases such as malaria and enteric infections. Harare is at a relatively high altitude and malaria transmission is limited. The report indicated a high level of destruction by slashing of maize crops, possibly as a malaria control measure. The report does not indicate whether increased surface pooling resulted from cultivation practices. Tap water was used to irrigate home gardens while illegal crops depended on rainfall. There was no indication of water storage.

Blockage of drains from whatever means tends to lead to standing water in which mosquitoes may breed. If the water is heavily contaminated with organic materials then *Culex quinquefasciatus* breeds. If the water is relatively unpolluted but muddy then malaria mosquitoes may breed. There was some use of organic and artificial fertiliser but no reference to the use of night soil or sewage that could contaminate leafy vegetables with enteric pathogens.

Non-communicable diseases

The report suggested that there may be a link between increased dust levels, eye irritation and asthma. It also recommended further research on the following health hazards which have implications for poisoning.

- 1 Agro-chemical runoff in surface water bodies used for domestic purposes,
- 2 Heavy metal and toxic chemical content of crops cultivated on land polluted by industrial effluent (especially in a valley beyond an industrial area);
- 3 Lead-uptake from vehicle fumes in crops grown along transportation routes.

About 40% of respondents used pesticides in their home gardens, except for those in the poorest groups. On illegal plots less than 10% used pesticides. The method of use, storage and disposal of pesticides was not discussed.

Malnutrition For almost 25% of those interviewed, some 60% of food consumed came from self-production. The report recommended further studies on the nutritional gains to households from consuming their own produce

Injury

Small hammer-mills for grinding maize had proliferated with the rapid increase in urban agriculture and were used by both maize purchasers and sellers. Such technology is likely to ease the burden of manual maize pounding and be beneficial. There is an associated problem of occupational injury from poorly guarded machinery.

Psycho-social disorders

There were a number of factors which could be associated with loss of well-being, insecurity and stress. Many of the interviewees had lost part of their crops due to slashing or stealing and there were intra-urban differentials. Loss rates were much lower in low density suburbs. The report noted important reductions in recreational open space and loss of biodiversity, especially of large animals valued for their aesthetic qualities. The report mentions an increasing crime rate with mature maize crops provide hiding places for muggers. Such a link is unlikely to be causal, as muggers could find alternative locations, but may further reduce the sense of well-being. The institutional response to urban agriculture appeared to be generally unresponsive.

1. Urban agriculture has a potential to contribute to the food and nutritional requirements of many urban and peri-urban communities and is promoted for this purpose. Smit (1996) discusses this production in terms of nutrition, food security and health benefit, especially for the very poor. He cites examples that suggest that the children of urban farmers have a better nutritional status than non-farmers at the same or higher income levels. Social benefits include community well-being and employment opportunities. For example, in Dar es Salaam urban agriculture was the second largest source of employment after petty trading and labour. The report suggests that poor urban farmers can contribute substantially to improving the environmental health conditions of their neighbourhoods through their activities. For example, about 27% of all garbage in Khartoum is said to be consumed by urban animals, mature garbage dumps its Calcutta produce substantial quantities of vegetables.
2. Table 21 provides a useful overview of the nature of urban farming systems in which health linkages must be sought.

Table 21. Urban and peri-urban farming systems (from Smit, 1996)

	Product	Location or technique
Aquaculture	Fish and seafood, vegetables, seaweed, fodder	Ponds, streams, cages, estuaries, sewage, lagoons, wetlands
Horticulture	Vegetables, fruit, compost	Homesites, parks, rights-of-way, roof-tops, containers, hydroponics, wetlands, greenhouses
Livestock	Milk, eggs, meat, manure, hides, fur	Zero-grazing, rights-of-way, hillsides, coops, open spaces
Agroforestry	Fuel, fruit, nuts, compost, building materials	Street trees, homesites, steep slopes, vineyards, greenbelts, wetlands, orchards, forest arcs, hedgerows
Other	Houseplants, medicines, beverages, herbs, flowers, insecticides	Ornamental horticulture, roof-tops, containers, sheds, beehives, greenhouses, rights-of-way, urban forests

5.4 Choice of crop

5.4.1 Communicable disease

1. Rice cultivation is nearly always associated with an increase in malaria. However, in sub-Saharan Africa malaria transmission is sometimes already at saturation level so that increases in vector breeding may have no effect. In some areas of West Africa the irrigated fields are colonised by a mosquito sub-species that appears to be a poor malaria vector (Service 1989b). However, the reduction in malaria prevalence may also have been associated with changes in human behaviour. There is a succession of different mosquito species in rice fields as sun-loving species are replaced by shade-loving species when the rice grows. The large amounts of fertiliser and pesticide used with HYVs may deter certain malaria vectors.
2. There are a range of communicable disease hazards associated with irrigation of food crops using wastewater in the peri-urban environment. *See recycling and waste reuse p51.*

5.4.2 Non-communicable disease

1. There are special occupational hazards associated with particular crops (Ghosh et al. 1979; Nag Anjali 1986). The agricultural tasks associated with these crops may tend to be gender specific. For example, women may be employed for tea and tobacco picking. Teapickers are exposed to high levels of pesticides used in tea growing. Tobacco cultivation is very labour intensive and requires labour in short duration peaks, which disrupts employment patterns and childcare (Brost 1981).
2. Certain varieties of crops, such as cassava, contain toxins. Promotion of these varieties may be associated with a real risk of poisoning among consumers. Production and consumption of the grass-pea is increasing in India,

Ethiopia and Bangladesh. Over-consumption of improperly cooked grass-pea leads to lathyrism, a neurotoxic disorder, common in young men (Haimanot et al 1990). The grass-pea is especially tolerant to drought, poor soils and pest attack. It can be intercropped and is useful for nitrogen fixation. These characteristics make it attractive to poor peasants, especially during times of stress. In an Ethiopian study, consumers were aware of its toxic potential but found it preferable to starvation (Haimanot et al. 1990).

3. In a recent review Listorti (1996a) suggests that pesticide hazards appeared to receive less attention than low level hazards like pollution by nitrates. I le also suggested that malnutrition had received far more attention than contamination of the food chain.

5.4.3 Malnutrition

1. Food security means physical and economic access to food for all people at all times. Lack of food security is associated with poor nutritional status, particularly in young children (Dearden and Cassidy 1990; Payne 1990). The malnourished child is more susceptible to communicable disease. Food insecurity is a concrete manifestation of poverty that may be more meaningful than income levels.
2. Changes in household food security and nutritional status can occur, for example, when projects affect food production, food availability, purchasing power and workload. Urban and peri-urban agriculture is considered an important way of improving nutrition for the urban poor. The produce is used directly and indirectly by the household to obtain food and income. However, not all low-income households benefit equally from food production activities. Cash from high value vegetable crops may be controlled by male members of the household who do not use it for the benefit of the elderly, women and children. Transitory food insecurity can be associated with seasonal shortages or, for example, a shift from subsistence to cash crops.
3. The type of crop grown is also important in terms of nutritional benefits. Crop development programmes may neglect staple root crops and coarse grains in favour of high protein or fine grain export crops. Promotion of export crops (often associated with structural adjustment programmes) may adversely affect production of food crops through competition for productive resources, but the available evidence is mixed (Cooper Well et al, 1990). Changes from subsistence to cash crops may reduce the income or security of vulnerable groups, reduce the production of foods for home consumption or increase the price of purchased foods so that income may be insufficient to buy food in local markets. Crops with a high value, high yield and high protein content may represent a health hazard to poor farmers by paradoxically increasing malnutrition (Lipton and de Kadt 1988). Such crops may not meet the needs of poor people for the following reasons. The poor need: `J subsistence rather than cash crops;
 - extra energy rather than extra protein;
 - reliable yields rather than high yields;
 - stable market demand rather than extreme price fluctuations;
 - varieties that are resistant to drought and disease, easy to store and require limited labour.
4. The effect of cash crop production on income and nutrition is mixed, as the following examples illustrate [(Fleuret and Fleuret 1980; Fillmore and Hussain 1984, Longhurst 1988).
 - Change from subsistence to cash cropping is usually accompanied **by** a reduction in crop diversity. The simplification of traditional diets can lead to nutritional imbalance and increasing malnutrition.
 - In Kenya, sugar production was significantly associated with malnutrition as was a switch from traditional weaning, foods to commercialised food substitutes (Fillmore and Hussain 1984).
 - Smallholder tea growing in Kericho district, Kenya, was associated with a serious reduction in home produced food (Fillmore and Hussain 1984).
 - A positive change in nutritional status was observed on a paddy rice development scheme in Sri Lanka. It was noted that rice was a traditional crop which had cultural and nutritional importance in the community.
 - The scheme provided a surplus of the traditional crop which Could be stored, against seasonal fluctuations, or sold (Holmboe-Ottesen et it. 1989).
 - The nature of the land and the market may ensure a more stable employment (and hence food purchase) from an export than from a staple food crop in the case of plantation crops such as tea.
 - In Africa, it has been suggested that change to modern varieties of crops may be less harmful than no change at all (Lipton and de Kadt 1988).
 - The poor usually obtain their sustenance more from vegetable than animal foods. Animal development projects may divert land from producing staple crops and reduce the food supply of the poor.
5. One of the main problems of urban agriculture for the poor is insecurity of land tenure. Much urban agriculture occurs on unused land to which farmers have no legal rights. There is a constant risk that loss of land and crops could occur at any time with devastating effects on livelihood (Dennerly 1996). A strategy of poor urban people is to grow and sell high value vegetables which have a short growing cycle on land for

land and crops could occur at any time with devastating effects on livelihood (Dennerly 1996). A strategy of poor urban people is to grow and sell high value vegetables which have a short growing cycle on land for which they have transitory access and use the profit to buy low value staples which could not be produced on the same land.

5.4.4 Injury

The cultivation, harvesting and processing of crops may expose workers to a range of injury hazards that crop specific. *See also agricultural labour mid its effects on health, p48, and mechanisation and agriculture, p48.*

5.5 Bio-accumulation of pollutants

1. Contamination of crops with heavy metals and the process of bioaccumulation in the food chain is cited as an important health problem (Smit, Ratta et al. 1996). The extent of the problem and the validity of solutions proposed are unclear and require further research. Trends in research and policy have included:
 - increasing concern about effect of soil contamination on sustainable agriculture;
 - inhibition of soil micro-organism activity by various heavy metals;
 - concentrations of heavy metals in sewage sludge and the different guidelines adopted in the N. America and Europe;
 - use of plants as bioaccumulators of heavy metals.
2. Contamination may occur through the air or from soils and irrigation waters. Air-borne deposition of heavy metals is frequently associated with road traffic and can substantially effect plant yield (Hassan, Ashmore et al. 1995). But aerosol deposited lead particles, for example, do not penetrate plant cuticles (Alloway 1995). Surface deposits on leaves can be substantially reduced by washing (World Health Organization 1995).
3. There is considerable variation of rate of root uptake according to plant species, soil type and element (Alloway 1995). Much of the literature on plant uptake is primarily concerned with deliberate extraction in order to decontaminate soil (Nanda Kumar, Dushenkov et al. 1995; Watanabe 1997). Varieties of *B. juncea* (L.) take up relatively large amounts of lead, chromium, cadmium, nickel, copper and zinc. The same plants can be grown in hydroponic beds and used to extract heavy metals from aqueous streams (Dushenkov, Nanda Kumar et al. 1995). A report on the human risks from contaminated lands in the UK is under preparation (C. Ferguson, Environmental Agency, *pers. comm.*). It focuses on the assessment of risk to those working on or living on contaminated lands or consuming garden produce grown on those lands. High concentrations of metals occur near urban complexes, metalliferous mines and major road systems and we may be experiencing a silent epidemic of environmental metal poisoning (Alloway 1995).
4. A number of hazardous pollutants are associated with road traffic but it is unclear whether respiration or ingestion is the most important exposure pathway (Mage and Zali 1992; World Health Organization 1995). Lead appears to have received most study. A Chinese study concluded that food uptake of lead was far more important than respiration. In the study area, a high percentage of children in rural (perhaps peri - urban) villages had clinical symptoms of lead poisoning and elevated blood levels, compared to urban children. Lead concentrations in cereals and beans were higher than in vegetables. A study of bus drivers in Bangkok observed most lead absorption from food, probably purchased from street vendors and kept uncovered. Air and water media were far less important (World Health Organization 1995). It has been suggested that a boundary crop should be planted beside roads (Smit, Ratta et al. 1996). However, Israeli and Japanese studies found little associated contamination (World Health Organization 1995).
5. Lead is a cumulative poison and has been widely monitored. Concentrations of lead and cadmium are much higher in the liver and kidney of animals and in crustacea and molluses than in crops or milk (United Nations Environment Programme 1992). A global literature survey concluded that elevated levels of lead in children were more common in urban than non-urban communities, when industrial hot-spots were excluded, and air lead levels shared a similar pattern (Anonymous 1994). There was also a correlation with soil and dust levels. Studies in Nigeria found high levels of lead in the dust from un-paved roads. Other sources of contamination were edible fish from rivers and streams contaminated with industrial waste and cooking salts from springs polluted by nearby mines. Important sources of lead in Mexico included the ceramics industry, which uses lead glazing.

5.6 Agro-chemicals

1. More than 1000 chemical compounds, biological and physical agents are used around the world as insecticides, fungicides, herbicides, rodenticides, fertilisers and antimicrobial compounds. They have been responsible for substantially increasing food production and also in the control of some important human diseases such as malaria and typhus. I-however, these agrochemicals also cause a wide range of health problems

varying from straightforward topical irritant reactions to complex systemic illness which can have both acute and chronic clinical effects (O'Malley 1997). Peri-urban horticulture uses large quantities of fertilisers and pesticides that are largely unmonitored and penetrate waterways and food chains posing a threat to human health both to farmers and consumers and may cause problems of pesticide resistant disease vectors. The inactive ingredients in pesticides, such as petroleum distillates may also have harmful effects on human health.

2. Key informant concerns included pesticide residues on horticultural produce, it was suggested that cooking denatures pesticides but it is not known if this is correct.
3. The agricultural-urban interface provides a wide range of potential exposure pathways (O'Malley 1997) such as occupation, environment and consumption. Examples include inadequate storage in the house, reuse of pesticide containers, poor mixing techniques and contamination of water or air environmental contamination, unintentional exposure during work and failure to use protective clothing (World Health Organization Commission on Health and Environment 1992). Important forms of exposure are: occupational, intentional (suicide) and non-occupational
4. Poisonings occur despite control measures because of widespread agrochemical misuse. Estimates from WHO indicate that world-wide 3 million people annually suffer ill-health from single short-term exposure to pesticides. Of these approximately 1 million are serious unintentional poisonings and 2 million are suicide attempts involving pesticides resulting in 220,000 deaths (World Health Organization 1986).
5. Unintentional acute and chronic pesticide poisoning is an occupational hazard of agricultural workers. It is a growing and serious problem, but poorly documented (Loevinsohn 1987; McCracken and Conway 1987 Pingali and Marquez 1990; Stephens, Spurgeon et al. 1995). The level of risk of exposure to chemicals is usually higher in intensive farming; and horticulture than in traditional fanning (World Health Organization Commission on Health and Environment 1992). This is of particular relevance to peri-urban agriculture.
6. Some 50 million people have regular contact with pesticides and 500 million have less regular contact. The latter category may be particularly at risk because they will usually be less well informed of the hazards. A disturbing trend is the unrestricted use of highly toxic organophosphates such as methyl parathion and monocrotophos. More older and more toxic pesticides are still available in stores and market places in developing countries. Their cheap price makes them attractive to smaller farmers who may thereby circumvent donor policy. This may be of particular concern in smallholder agricultural development.
7. There are also an unknown number of domestic animal deaths from pesticide exposure.

5.6.9 Communicable disease

1. A major setback in the use of pesticides for public health has been the development of resistance in many disease vectors. Field breeding mosquitoes are one of the non-target organisms affected by widespread pesticide use. Cross-resistant strains are selected which are difficult for the public health sector to control. The prevalence of malaria may then increase. This problem could be reduced some categories of insecticide were reserved for public health use, as has happened in Sri Lanka. However, such schemes are difficult to regulate and do not overcome problems of cross-resistance,

5.6.2 Non-communicable disease

- I - Poisoning can cause both non-communicable disease and injury. For convenience we discuss all forms of agrochemical poisoning in this section.
2. Fatality rates vary from 1% to 91% in cases presenting for treatment according to the level of health services available. Additionally, over 700,000 people a year are thought to suffer from the chronic effects of long-term exposure. The scale and nature of such effects may be underestimated. The symptoms of pesticide poisoning may be incorrectly ascribed to other causes.
 3. Acute pesticide poisoning has received more attention than the chronic effects of exposure. The acute clinical effects of pesticide poisoning are very varied. For example, organophosphates can cause a range of acute symptoms including diarrhoea, nausea, central nervous system excitation, irritation of the skin and upper respiratory tract, decreased pulse rate leading to dizziness and collapse, headache, memory impairment and loss of sensation (Rosenstock, Keifer et al. 1990; Amr, El Batanouni et al 1993; Stephens, Spurgeon et al. 1995). Other pesticides can cause convulsions, cognitive impairment, liver and kidney impairment, lung fibrosis and coma (O'Malley 1997).
 4. Circumstantial evidence was published of increased adult male mortality in intensive rice production systems in North Luzon, Philippines (Loevinsohn 1987). Detailed studies at the International Rice Research Institute (IRRI), in the Philippines, tended to confirm the evidence of chronic poisoning (Pingali and Marquez 1990). The studies questioned whether the benefit of extra crops produced was higher than the cost of the

additional ill-health. IKRI reiterated the need for integrated pest management and have developed more pest resistant strains of rice to reduce pesticide use.

5. Chronic illness has also been associated with long term pesticide exposure and residues in foodstuffs due to concentration of agrochemicals in the food chain, including red meat, poultry, vegetables and eggs (Forget, Goodman et al. 1993). Residues are found in human milk and the levels ingested, particularly by nursing infants, are often many times greater than the internationally acceptable daily intake (Food and Agriculture Organization and World Health Organization 1988).

5.6.3 Public Awareness

1. Many surveys of pesticide use identify lack of knowledge and improper practices as the main causes of poisonings (Forget, Goodman et al. 1993). Low levels of literacy and education with poor access to training increase the risk of pesticide poisoning. Pesticide is often applied by itinerant, unskilled, unsupervised operators. It is still common to observe storing, mixing, application and disposal without adequate safety precautions. Protective clothing of the type used in developed countries is too expensive and unsuitable for hot countries. Poor access to water and soap for decontamination is a further risk factor. Operatives frequently eat, drink and smoke during spraying operations. Aerial spraying of insecticides often contaminates operatives, casual bystanders and local fauna, resulting in serious levels of exposure especially to organophosphorous type compounds.
2. Lack of knowledge of pesticide toxicity may not completely explain dangerous application practices. Although a range of studies in Forget et al (1993) suggest that many farmers are not aware of the dangers of poisoning, a recent survey in Ghana found that the majority knew pesticides were poisonous to humans (Yvon 1997). Despite this awareness, very few farmers used protective clothing or masks when applying chemicals. Many did not worry about protecting their skin and mixed the solutions with their bare hands even though they all had suffered minor skin irritation and respiratory difficulties after spraying. There is a need to develop cheap protective clothing suitable for tropical climates and improve pesticide application technology such as better formulations, increased specificity and safe, simple application equipment to complement farmer education and training.

5.6.4 Non-occupational agro-chemical poisoning

1. Unintentional mass poisoning with agro-chemicals is dramatic but rare. It occurs when people consume treated grains or contaminated stored produce. In Iraq some 6350 people were admitted to hospital and more than 459 died, after eating bread prepared from cereals treated with methyl mercury fungicide (Bull 1982). Food contaminated with the organochlorine endrin has caused several clusters of illness (Rowley, Rab et al. 1987).
2. Unintentional poisoning due to the use of pesticide containers as cooking utensils, for water storage and collection is also a major hazard. Such empty containers are often sold in the markets to poor people. Poor labelling may cause people to ingest insecticide by mistake. Insecticide taken as sugar in Dar es Salaam in 1974 caused 28 hospitalised deaths (Meakins 1991).
3. Pesticide residues in locally grown vegetables are frequently far in excess of the acceptable limits. Green leafy vegetables are especially at risk (Conway and Pretty 1991). Many species of wild food, including fish, molluscs, crustacea, insects and vegetables, are harvested among cultivated crops. Such foods are especially important for the poor. Pesticides may either remove or contaminate such foods. Exported foods, including fruits, fish and meats, are rejected at the port of entry in the EC, if they contain higher residues of pesticide than locally grown produce.
4. Pesticides, particularly herbicides, have been found in drinking water. High levels of chlorinated hydrocarbon pesticides have been reported in water in Colombia, Malaysia, Thailand and Tanzania (World Health Organization Commission on Health and Environment 1992).
5. The global use of nitrogen fertilisers has increased exponentially since the second world war. Much of the recent increase has been in developing countries and in support of high yield variety cereals. Most fertiliser is lost to surface and groundwater, finding its way into drinking supplies. There is a documented risk that nitrates may be converted to nitrites in the human gut through the action of bacteria (Conway and Pretty 1988). Nitrites bind to haemoglobin, impairing the transport of oxygen. The potential risk is greatest in bottle-fed infants and gives rise to the blue-baby syndrome. At present the condition is rare but there is concern for its future increase. *See also pollution of water by agriculture, p47, and nitrates and nitrites, p69.*
6. Nitrogen and phosphate contamination of the drinking water reservoirs can stimulate production of harmful toxins by blue green algae (Turner, Gammie et al. 1990).

5. Chronic illness has also been associated with long term pesticide exposure and residues in foodstuffs due to concentration of agrochemicals in the food chain, including red meat, poultry, V128-1 tables and eggs (Forget et al. 1993). Residues are found in human milk and the levels ingested, particularly by nursing infants, are often many times greater than the internationally acceptable daily intake (Food and Agriculture Organization and World Health Organization 1988).

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2. Lack of knowledge of pesticide toxicity may not completely explain dangerous application practices. Although a range of studies in Forget et al (1993) suggest that many farmers are not aware of the dangers of poisoning, a recent survey in Ghana found that the majority knew pesticides were poisonous to humans (Yvon 1997). Despite this awareness, very few farmers used protective clothing or masks when applying chemicals. Many did not worry about protecting their skin and mixed the solutions with their bare hands even though they all had suffered minor skin irritation and respiratory difficulties after spraying. There is a need to develop cheap protective clothing suitable for tropical climates and improve pesticide application technology such as better formulations, increased specificity and safe, simple application equipment to complement farmer education and training. In horticulture there are believed to be many opportunities to reduce the amount and frequency of spraying, although it may be over-optimistic to suggest that use of pesticides can be entirely eliminated

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6. Nitrogen and phosphate contamination of the drinking water reservoirs can stimulate production of harmful toxins by blue green algae (Turner et al. 1990).
7. Increased use of urban solid waste as a fertilizing material is a realistic alternative to use of chemical fertilisers in peri-urban areas and is dealt with under the section on waste recycling and reuse. It has been suggested that there should be co-ordination between waste management agencies, local authorities and local farmers to set

up systems for sustainable waste management which can provide a reliable supply of urban waste to near-urban farmers (Lewcock 1995).

5.7 Integrated pest management systems

1. Effective pest management is essential for small scale farmers. However, pesticides and alternative approaches suitable for developed countries often do not work in the developing world. Alternatives to chemical pesticides have included plant breeding for resistance, biological control, microbial pesticides, botanical pesticides and integrated pest management. Farmer's attitudes to pests and pest management is also important. Despite knowledge of the harmful effects of chemical pesticides, farmers continue to use them. Constraints to the introduction of non-chemical pest management techniques include land availability and land ownership. The use of chemical pesticides is widespread and almost universal during production of vegetables for external markets. Farmers in Ghana felt that they would rather purchase chemicals on credit than run the risk of not spraying and having crop failure (Yvon 1997). Considerable support may be required to develop alternative agricultural risk reduction strategies and the health benefits may provide an incentive.
2. The prospects for IPM totally replacing pesticide use in mixed vegetable crops was regarded as poor by Drs 3 Mumford and C. Crissman *pers. comm.*). Improved safety would then depend on new formulations of existing products improved application strategies and better farmer education. There is general agreement that pesticides are often over-used. There is plenty of room for reduction in use through farmer education and this will have associated health benefits.

Box 11 NRI research plans for IPM

An IPM research programme for peri-urban vegetable production is planned (Natural Resources Institute 1996). More intensive production is required, but pesticide misuse is recognised as an increasing concern. The programme plans to survey pesticide poisoning, contamination and misuse in a number of West and Central African countries. None of these countries are believed to monitor health effects or keep records of poisoning. The paper expresses concern about unwanted pesticide dumping by donor countries as part of aid donations. There is diversion of subsidised cotton pesticides to vegetables. Other familiar problems reported were: pictograms not understood, insecure storage in living areas, inadequate protection, contamination, poor disposal, poor hygiene, re-use of containers, misuse as fish and bird poisons, misuse as public health insecticides, substantial residues in market vegetables. It was suggested that farmers understood acute poisoning but not chronic poisoning (through gradual build-up). Concern was expressed about the privatisation of extension services as the private sector may not have the technical expertise to protect the public health. The report surveyed the research activities of a range of donors and institutions. Few referred to human health.

5.8 Pollution of water by agriculture

1. Agriculture is the largest consumer of water resources and agricultural runoff to surface or groundwater contains high concentrations of salts, nutrients and agrochemicals which contribute to the deterioration of water quality. Not only does use of untreated wastewater represent a health hazard that may be disseminated by agricultural production but increased use of agricultural inputs, such as pesticides and chemical fertilisers, have led to unprecedented chemical loads in water bodies (Food and Agriculture Organization 1993).
2. The definition of a water pollutant is any living organism, mineral or chemical whose concentration limits the beneficial use of water. Agricultural activity may contribute with types of pollutants:
 - suspended solids, e.g. from soil erosion processes;
 - living organisms, e.g. through irrigation with untreated wastewater and use of compost;
 - agro-chemicals, e.g. pesticides and fertilisers.
3. A study in Peru showed that poor organic waste disposal and use of wastewater for agriculture lead to biological contamination of groundwater with numbers of coliform bacteria exceeding WHO recommended limits (Ventura Napa 1992). Infiltration of untreated wastewater used for agriculture can also cause high concentrations of nitrates in groundwater, although the significance of this compared to nitrate contamination due to excess fertiliser use is not clear. A study on nitrate pollution of groundwater in Gaza in 1995 looking at fertilisation practices and public water supply suggested that in many areas the nitrogen already dissolved in the groundwater from waste percolation was more than enough to cater for the needs of agriculture and any additional nitrogen fertilisation was unnecessary (M. Gischler *pers. comm.*). See also nitrates and nitrites, p51.

4. There is a growing need to preserve water quality in a sustainable way without adversely affecting agricultural production and the following procedures have been advocated (World Health Organization Commission on Health and Environment 1992x, Ongley 1996).
 - Establishment of water quality monitoring systems for agricultural water uses.
 - Prevention of adverse agricultural activities.
 - Minimisation of adverse effects from agricultural chemicals by use of alternative pest management strategies.
 - Education of communities about the pollution impacts of the use of fertilisers and chemicals on water quality and food safety.

5.9 Agricultural labour and its effects on health

5.9.1 Injury

1. Occupational health is an important issue in tropical agriculture but has been neglected. A review subdivided agricultural occupational disorders into three categories (Rainbird and O'Neill 1993):
 - disorders associated with the use of pesticides, *see 56, Agrochemicals*;
 - disorders associated with biomechanical and postural demands-,
 - occupational diseases.
2. The poor postures and heavy physical demands associated with agricultural tasks in the tropics are a major cause of musculo-skeletal injuries, although there has been little research on the extent of such disorders in developing countries. The two most important aspects are spinal loading and the repetitive movement of the same part of the body over extended periods of time (repetitive strain injuries). The review quotes several examples of musculo-skeletal problems including back pain from using sickles and short handled hoes, and tenosynovitis among tea pickers. Different methods of water carriage including on the head, the hip and on the back are also associated with a variety of negative biomechanical effects which can cause asymmetric posture, abnormal curvature of the spine and arthritis of the spine and hips. Rainbird and O'Neill (1993) call for a survey on the incidence of work-related overuse disorders, to identify the tasks and tools with which they are associated, and to determine the effect on productivity.
3. Occupational injuries are an important cause of ill-health in agricultural labourers. For example, very high rates of injury are reported among sugar cane workers. The injuries occur from the use of heavy machetes (Phool Chund 1991). In Uganda, although only 21% of the employed persons were engaged in agriculture in 1987, they accounted for 33% of all occupational injuries (Sekimpi 1992). Traditional agricultural hazards accounted for 5% of time spent off work by casual rural labourers in India (Lipton and de Kadt 1988).

5.9.2 Malnutrition

1. Landless agricultural labourers are a vulnerable group because of low and unstable wages and low levels of employment (Upton and de Kadt 1988). They may, for example, be unable to purchase sufficient food during the slack season. The high energy requirements of manual labour may exceed the energy levels of food intake.
2. Women gain mixed benefits from agricultural labour. The extra income may provide extra food but the type of work may be incompatible with child care. As men move out of the fields and into the cash economy, women's role in subsistence production has increased. The replacement of subsistence crops by cash crops often has a direct effect on women. Where a woman's workload is increased there may be reduced time to care for her family or attend at health clinics. This increases children's exposure to diseases, malnutrition and injuries.

5.10 Mechanisation and agriculture

5.10.1 Communicable disease

1. Reduction of livestock associated with a switch to mechanised agriculture has been associated with malaria outbreaks when the vector switches to feeding on a human host (Ault 1989). Mechanisation may increase the number of rice crops that can be grown during the year and extend the malaria transmission season (Service 1989b). Increased mechanisation may also reduce the transmission of vector-borne diseases. Larger, more fertile fields and improved drains reduce breeding sites. Schistosomiasis may decrease as a result of decreased water contact (World Health Organization Commission on Health and Environment 1992a).

5.10.2 Malnutrition

1. Agricultural mechanisation may increase the demand on women for low-productivity and physically demanding work. At the same time, it may reduce the male workload and increase male control over the processes. Even where labour saving technologies have been introduced for traditional female work, they have sometimes been handed over to male control (Rogers 1981). This decreases the income of women and their Food security, reinforces their position as unable to manage machines, places strains on their nutritional

resources and reduces the time and energy available for child care and food preparation. 1. Introduction of mechanical rice husker in Bangladesh. controlled by men, removed one of the few income generating options open to poor rural women (Greeley 1987).

2. Reducing labour intensive occupations and displacing labourers can lead to reduced food security for vulnerable groups. The shift in Asia from increasing draught power to tractors usually displaces labour without increasing output. This shift is often encouraged by providing credit or by subsidising fuel and tractors. Cost of tractor hire/use is so great in smaller fields that it drastically reduces family income from land especially in regions of high unemployment and results in food scarcity as in the case of most of Lesotho (Meakins }.

5.10.3 Injury

1. The frequency of traumatic injuries is likely to increase with mechanisation. Tractors are well known as an important cause of agricultural injuries. They are unstable because of their need for high ground clearance. Adults and children living in rural areas of developing countries often have very little appreciation of the dangers associated with these vehicles. In the UK most farm injuries are also associated with machinery (Conway and Pretty 1991).
2. An extensive study in India identified the causes of agricultural injuries. Although spades and sickles were most commonly implicated; severe injuries were associated with the use of poorly designed machines including fodder cutters and threshers. 45% of fodder cutter injuries were sustained by children (Mohan et al. 1992).
3. The high noise levels associated with agricultural machinery may induce hearing loss as well as stress and behavioural problems (World Health Organization Commission on Health and Environment 1992a)

5.11 Agricultural processing industries

In addition to the general range of occupational hazards of industry, including injury and noise, there are some specific health hazards of agricultural processing industries. These hazards are associated with non-communicable disease.

5.11.1 Non-communicable disease

1. Commodities such as tea, coffee, sugar, jute and pyrethrum require processing in industrial plants. The processing plants expose labour to silica dust, a variety of allergens and spore contaminants that can cause or aggravate lung disease (Blanc 1984; Yach et al. 1984; Ye et al. 1988). Women form a high and poorly paid proportion of such labour. There is evidence that the prevalence of chronic respiratory symptoms is higher in women workers, although they are usually non-smokers (Zuskin et al. 1979). Exposure to tobacco dust causes respiratory, skin, eye and gynaecological problems (Nag Anjali 1986). Protective clothing is often not provided. Workers exposed to grain dust in South Africa had a high prevalence of irreversible loss of lung function compared with controls. There was a high prevalence of cough, expectoration, wheeze and watery eyes in grain workers. These symptoms were not related to duration of employment or smoking habits (Yach et al. 1984).
2. Rice millers in Malaysia suffer from acute and chronic irritation of the eyes, skin and upper respiratory tract; allergic responses such as nasal catarrh and asthma; and lung changes associated with dust induced lung disease (Lim et al. 1984).
3. A respiratory disease is associated with handling of bagasse. Bagasse is the residual fibre of sugar cane after the juice has been extracted. It is usually compressed and stored for drying. It is used for board and paper making. Fungi and bacteria grow in the bagasse and cause an allergic reaction. It is estimated that the disease develops in up to 50% of those exposed. It can be prevented by modified storage of bagasse (Phool Chund 1991).
4. Textile processing produces large quantities of air-borne fibres that cause chronic lung disease, such as byssinosis in cotton workers. This can reactivate latent tuberculosis. In the cotton industry in Sudan, byssinosis prevalence is as high as 49% (Khogali 1970). Other respiratory symptoms are common, but no increase in tuberculosis was reported (El Karim and El Hag 1985). Byssinosis prevalence was much higher in Manchester cotton mills than in artificial fibre mills (Fishwick et al. 1990).
5. Kapok workers in Sri Lanka are reported to develop chronic bronchitis and mill fever. Paprika splitters and chili millers are also known to develop allergic respiratory disease (Sekimpi 1992).
6. Raw silk processors are exposed to a dust derived from the gum which binds silk strands together. In Sri Lanka occupational asthma was associated with degree of exposure to this dust (Uragoda and Wijekoon 1991). In China, pneumoconiosis has been reported in silk workers (Liu Tie-min 1990).

7. Large quantities of water are used in agricultural processing, and organic contaminants may be discharged into surface waters that are used for domestic supply. Post-harvest processing of agricultural produce can cause more severe river pollution than discharge of raw sewage (Agarwal et al. 1981). The effect of discharges on downstream communities and on fish is seasonal. Much produce is processed during the dry season when temperatures are highest and river flow rates are lowest (Caincross and Feachem 1980).

8. Many of the Colombian population derive drinking water directly from rivers. Rivers were highly polluted by discharges from the coffee, sugar and paper industry. A system of fining was introduced that has encouraged producers to recycle some of the waste (Agarwal et al. 1981).

6. Fisheries 6.1

Summary

Table 21 Summary of health linkages for fisheries

Development Sub-category	Communicable diseases	Non-diseases	Malnutrition	Injury.
Coastal capture fisheries	Domestic sewage pollution, exposure to waters, post-harvest contamination	Occupational exposure waters contaminated chemicals, post-harvest contamination, toxic blooms, exposure to	Destruction of wild stocks	Sharp knives and machinery used for fish processing
Aquaculture	Vector breeding water contamination human and animal excreta, consumption infected fish, water contact, post-contamination, misuse	Poisoning by fish chemicals, fish poisons and toxic algal blooms. occupational exposure allergens	Destruction of wild stocks	Sharp knives and machinery used for processing
Integrated aquaculture	Mixing domestic and fish			

- The major link between aquaculture and human health is through nutrition. Small scale aquaculture can provide an important source of protein but large scale commercial enterprise can reduce access to this resource.
- Fish products can be affected by a wide range of non-communicable contaminants including, industrial and agrochemicals, antibiotic residues and toxic algal blooms.
- Microbial contamination of fishponds can occur by fertilisation with excreta and wastewater. Pathogens can pose a potential health risk to pond workers, fish processors and consumers.
- Fishponds can potentially create or increase vector breeding sites for malaria and schistosomiasis.
- All fisheries can involve substantial post-harvest processing which have a range of occupational health risks.
- There is a need for a food quality standard for aquaculture produce to ensure microbial and chemical safety of farmed fish.

6.2 Introduction

This section includes both fresh and salt water fisheries. Although we will briefly consider the effects of capture fisheries and coastal cities, the main aquatic resource issue at the pen-urban interface would appear to arise from increasing the productivity of small scale freshwater aquaculture systems.

6.3 Coastal management and human health

1. 'Five coastal 8% of the world is home to 75% of the world's population and includes the poorest people on the planet (Verlaan 1997). Most of the projected doubling of the world's population by 2050 is expected to be concentrated in coastal cities (Food and Agriculture Organization 1991). Coastal cities bear the cumulative burden of environmental stress both from overcrowding along the coast itself but also from upstream and inland development. Populations of developing countries derive between 40-100% of their animal protein from the sea and seafood is an essential nutritional supplement to the mostly carbohydrate diet of the poor in Asia and Africa (Food and Agriculture Organization 1991).
2. The principle anthropogenic threats to human health from capture fisheries are due to contamination by sewerage, and pollution from chemicals and heavy metals.

3. Working; in, bathing in or consuming seafood from water contaminated by sewerage leads to exposure to a variety of communicable diseases including ear, eye, skin infections, infectious hepatitis, poliomyelitis, salmonella, Shigella, campylobacteriosis, cholera, typhoid, meningitis and pneumonia. Seawater pollution from chemicals and heavy metals leads to exposure to various non-communicable diseases.
4. The destruction of coastal and estuarine fisheries as a result of water pollution from cities has been widely documented (Rossi-Espagnet et al. 1991). Examples include Lake Maryut in Egypt, the Gulf of Paria, Manila Bay, the Bay of Dakar and the Indus delta.

6.4 Aquaculture

1. Aquaculture refers to the practice of fish culture (notably tilapia and carp) and the growing of certain aquatic plant crops such as water spinach, water chestnut, and duckweed.
2. Worldwide fish production from aquaculture amounts to about 14 million tonnes of which nearly 90% comes from inland habitats and approximately 90% is based in Asia. There are many different forms of aquaculture from small scale subsistence fish farming to intensive commercial operations, practised in a variety of settings including brackish ponds, reservoirs, rice paddies, integrated fish-livestock farms and wastewater fed fishponds. The majority of inland aquaculture in the tropics is concerned with low value finfish species and is mostly pond-based (Beveridge and Phillips 1993). Peri-urban aquaculture tend to be small scale, semi-intensive or extensive pond systems or intensive fry nurseries (J. Turnbull, S. Adams *pers. comm.*).
3. All fisheries can involve substantial post-harvest processing in the form of gutting, peeling, slicing, canning, freezing and cooking which have a range of occupational health risks. All aquaculture schemes have interactions with other development projects and cause changes to the environment that have a range of potential health impacts on local people. The main public health issues of developing world aquaculture are water-borne diseases, toxic algal bloom, microbial safety of farmed aquatic produce and trace environmental contaminants.
4. A Codex standard on aquaculture food is under preparation and an expert consultation at FAO on the use of chemicals in aquaculture is to be published soon (FAO, *pers. comm.*). Priorities for safe fish production systems have not yet been established and there is a need for epidemiological studies.

6.4.1 Communicable disease

Two main areas of concern are pathogens from wastewater reuse and creation of vector breeding sites. See *also recycling and waste reuse. p63, and Table 10. p24.*

6.4.1.1 Excreta and organic waste reuse in aquaculture

1. The fertilisation of aquaculture ponds with human and animal wastes has occurred for thousands of years in Asia, and it is believed that approximately two-thirds of the world yield of farmed fish is obtained from ponds fertilised with excreta and animal manure (Mara and Cairneross 1989; Edwards 1992). Traditional methods of fish culture in Asia employ a wide variety of organic inputs and such reuse aquaculture systems include overhanging latrines, faecally polluted surface water, cartage of urban nightsoil to aquaculture ponds, and sewage systems.
2. Excreta related diseases are very common in developing countries and so potential threats to public health from excreta reuse in aquaculture must be minimised. There is ample evidence that excreta and wastewater contain high concentrations of excreted pathogens (bacteria, viruses, protozoa and helminths) which can potentially cause at least 30 diseases of public health importance (Feachem et al. 1983). Fish, fish products and fish ponds can easily become contaminated with these pathogens which may affect workers, processors and consumers. However, aquacultural use of excreta and wastewater is only a potential risk to health and will only result in actual health risks if all of the following occur.
 - Either the infective dose of excreted pathogen reaches the pond or the pathogen multiplies in the pond to create an infection dose.
 - The infective dose reaches the human host.
 - The host becomes infected.
 - The infection causes disease or transmission of disease.
3. There are three main potential health risks associated with the aquacultural use of excreta and wastewater (Feachem et al. 1983):
 - passive transfer of excreted pathogens by fish and cultured aquatic macrophytes
 - transmission of trematodes whose lifecycles involve fish and aquatic macrophytes;
 - transmission of schistosomiasis.

4. Most aquaculture systems using raw sewage or primarily sedimented excreta do not appear to constitute a significant public health hazard. Calcutta has the largest area of wastewater-fed fish ponds in the world. There is a low potential risk of disease transmission to consumers because trematode infections are not endemic to West Bengal, the ponds are emptied and cleaned each year to remove the bottom mud and vegetation and the fish are consumed well-cooked (Mara and Cairncross 1989). However, there have been few good epidemiological studies on human waste reuse in aquaculture to see whether these practices actually cause significant increases in disease. A review of the epidemiological evidence for disease transmission associated with aquaculture use of excreta and wastewater found clear evidence for transmission of certain trematode diseases in excreta fertilised aquaculture, principally Clonorchiasis and Fasciolopsiasis (Blum and Feachem 1985). They found no studies dealing with occupational exposure to schistosomiasis (although it is still considered a major health risk for aquaculture workers) and there was no conclusive evidence for passive transference of excreted pathogens particularly of bacterial disease transmission.
5. A broader range of epidemiological studies is required before statements of actual health risks of waste fed aquaculture can be made. However, there is evidence that excreted pathogens can survive for a sufficient length of time to pose a potential health risk to pond workers, and in some cases survival times are long enough to pose potential risks to fish processors and consumers (Mara and Cairncross 1989). A realistic appraisal of potential health risks can provide a basis for microbiological criteria for excreta and waste water for aquaculture. The transmission of Clonorchiasis and Fasciolopsiasis occurs in very restricted areas of Asia where the cultural preference is for eating raw fish and aquatic vegetables (Feachem et al. 1983). The transmission of these can only be prevented by changing eating habits, ensuring that no eggs enter the pond or by controlling the intermediate snail host. The appropriate helminthic quality guideline for all aquacultural use of excreta and wastewater is the absence of all viable trematode eggs.
6. WHO guidelines for microbiological quality of treated excreta and wastewater for aquacultural use are zero viable trematode eggs and less than 1000 faecal coliform bacteria per 100ml for fishpond water (World Health Organization 1989). These guidelines reflected judgements based on the best epidemiological evidence available at the time. One epidemiological study to test the validity of the guidelines in Indonesia suggested an association with childhood diarrhoea at these levels (Blumenthal et al. 1991/2).
7. The most effective way to prevent human infection from excreta and wastewater use is to kill pathogens by treatment of wastes according to the Engelberg guidelines. *See recycling and waste reuse, p63*. However, many developing countries lack adequate waste water treatment procedures. One alternative is to connect fish ponds in series and avoid harvesting from the first pond. A stable phytoplankton community should be established before fish stocking and then wastewater should be added slowly. Loading of wastewater into fish ponds must be suspended for two weeks prior to harvest in order to eliminate *Cryptosporidium*.
8. Aquaculture produce can also be treated for pathogen removal. Fish should be held in clean water for 2-3 weeks prior to harvest to evacuate their guts and thus decrease their contamination with faecal micro-organisms. Threshold concentrations of bacteria in fish muscle must not be exceeded.
9. The culture of molluscs in waste water fed systems is not advisable because of their propensity to accumulate large quantities of contaminants, both microbial and chemical. The pollution by human excreta of waters used for harvesting shellfish can be the source of many enteric infections. An epidemic of shell-fish borne hepatitis A in China in 1988 affected 292,000 persons and was related to the consumption of contaminated clams (World Health Organization 1991c).
10. A fourth component of a safe system is control of all human exposure to pathogen risk, including aquacultural workers, processors and consumers. For example, schistosomiasis control by treatment, snail control with molluscicides, local education about precautions in wastewater fed fishponds and provision of sanitation facilities.
11. There is a need for monitoring and evaluation of all measures including wastewater treatment, water quality, produce; quality and disease incidence to determine the actual health risks.

6.4.1.2 Other pathogens affecting the food safety of aquaculture produce

See also food safety, p77 and Table 10, p24.

1. Quality control is essential to ensure the safety of aquatic produce post harvest during preparation and processing. Contamination can occur at many stages. After capture, produce must be cleaned, gutted, refrigerated and stored. For example peeling of shrimps is the process which affords the greatest risk of Salmonella contamination (Pullin et al. 1991). The principles of Hazard Analysis and Critical Control Point System (HACCP) have been applied to aquaculture production to control food safety hazards (Reilly and Katerstein 1996). This permits a systematic approach to the identification, assessment and control of hazards

and risks associated with the production, distribution and use of aquatic foods. The USFDA estimated that the introduction of HACCP by fish processors in the United States had averted some 20-60% of cases of seafood borne illness. Codex Alimentarius Commission are in the process of preparing a standard for aquaculture foods (R. Subasinghe, FAO, *pers. comm.*).

2. The habit of eating raw or partially cooked aquatic organisms and aquatic plants is increasing among some communities and it is associated with an increasingly high prevalence of parasitic diseases, particularly trematode infections. In Indonesia eating raw or half-cooked sea food has resulted in an increase in Anisakiasis (Cross and Murrell 1991). The effects of cross species transmission are also an issue with integration of aquaculture into other forms of natural resource management. Infection with *Clotorchis sineirsis*, the Chinese liver fluke, is increasing in Taiwan. The increase in the popularity of eating raw fish, the new policy of raising pigs close to local fish ponds and farmers eating the fish uncooked are considered responsible (Cross and Murrell 1991).
3. Most of the food safety hazards associated with products from aquaculture can be controlled by good fish farm management practices and appropriate consumer education regarding such risks as eating raw or partially cooked products.

6.4.1.3 Integrated aquaculture and the risk of influenza pandemics

1. Human influenza A pandemics commonly arise by genetic reassortment between human and avian viruses in pigs (Scholtissek and Naylor 1988). It has been suggested that the increase of aquaculture integrated with keeping farm livestock could result in a potential human health hazard by bringing together the two reservoirs of influenza A viruses. These risks may not have been previously considered in the assessment of health constraints of integrated animal-fish farming. One mitigation measure would be to develop aquaculture systems where pigs are enclosed separately from waterfowl or to discourage the farming of fish in conjunction with pigs and poultry. Other authors argue that the inferred link between fish farming and human influenza pandemics is overstated (Edwards et al. 1988; Edwards 1991). Pigs and poultry have been brought together on traditional mixed farms worldwide for centuries and there is no reason why fish farming should pose a greater threat. Also co-location of pigs and poultry together to supply manure for aquaculture is not common. In most small scale aquaculture developments, only one species of livestock is used on any one farm in a feedlot.

6.4.1.4 Vector borne disease

1. Small dams are built for many reasons including fish farming and water supply. They are often built informally, to low standards and to meet local needs, and are not recorded in any inventory. In Africa they provide breeding sites for vectors such as malaria mosquitoes and schistosomiasis snails. In India and Pakistan fish ponds could breed malaria mosquitoes although the water may often be too contaminated. The health hazard represented by large numbers of small reservoirs is likely to be very great because of the total area and shoreline that they represent. In Nigeria, the surface area of small impoundments is at least 3.5 times, and the shoreline at least 10 times that of large dams. In Zimbabwe there are between 10,000 and 20,000 farm darns. In Nyanza province, Kenya, some 50,000 small impoundments were created in 3 years during the late 1950's (Jewsbury and Imevbore 1988).
2. Fish ponds become mosquito breeding sites when they are poorly managed. Good management involves removal of surface and emergent aquatic vegetation which provides shelter for mosquito larvae. Some species of mosquitoes such as *Anopheles sudaicus*, *merus* and *melas* are especially adapted to brackish water habitats. Consequently, coastal ponds can also become important breeding sites for vectors such as malaria mosquitoes. Brackish coastal fish ponds and lagoons in Indonesia are important breeding sites of malaria mosquitoes when they are covered with an algal mat or abandoned.

6.4.1.5 Antibiotic resistance

1. In intensive and semi-intensive aquaculture systems, artificial feeds supplemented with antibiotics are used to prevent the spread of fish pathogens and to improve feed conversion ratios. Antibiotics are not commonly employed in peri-urban tropical freshwater aquaculture although they are used to treat broodstock in Asia (M.Beveridge, A.Adams, J.Turnbull *pers. comm.*).
2. The use of antibiotics in aquaculture has caused an increase in drug resistance among many groups of important fish bacteria to a range of medicines (Inglis et al. unpublished). A study of antibiotic resistance of bacteria from aquaculture facilities in 5 South East Asian countries in 1993 showed that resistance to oxytetracycline was very high and resistance to erythromycin and streptomycin was also common. Multiple drug resistance was widespread in Bangladesh and Thailand. There is little monitoring of the use of

antibacterial agents in aquaculture, although a monitoring-, network has been established in South East Asia (Inglis et al. unpublished).

- Current knowledge of the health and environmental impact of antibiotics use in aquaculture is poor. The potential human health hazard associated with the use of antibiotics in intensive fish production is a matter of current debate (see Table 22), Residues may remain in fish for human consumption. Antibiotics released into the environment can lead to the development of antibiotic resistant bacteria in the food chain. Abuse of antibiotics that are important in controlling human diseases (e.g. chloramphenicol used in human enteric infections) could facilitate the development of resistance in human pathogens. Some countries retain drugs exclusively for the use of humans although the effectiveness of this depends on the control procedures (*pers. comm.*). Most aquaculturalists are not informed about the practice of rotating drug use to prevent development of resistance (Pullin et al. 1991). Antibiotic use can also lead to rejection of products in export markets as many countries now refuse to import shellfish which have been treated with antibiotics.

Table 22 Potential effects on human health associated with the use of antibiotics in fish (Modified from Beveridge and Phillips 1993)

Drug	Persistence of Antibiotic Residues	Potential risks for human health
Chloramphenicol	48-72 hours	Bone marrow aplasia
Oxytetracycline	15-20 days	Digestive disorders, hepatorenal disorders
Erythromycin	48-72 hours	Rare hypersensitivity reactions
Sulphonamides	8-15 days	Hepatorenal disorders, leukopaenia, allergy
Trimethoprim	48 hours - 5 weeks	hepatorenal disorders, leukopeania, allergy

6.4.1.6 Occupational infections and mycobacteria

- A new health hazard to tilapia hatchery workers in the Philippines has emerged with a change in breeding technique. Workers now spend longer wading in the ponds and suffer from an increase in foot infections (Pullin et al. 1991).
- A particular occupational health problem for peri-urban tropical fish farmers is *Mycobacterium marinum*. This is a rare cause of skin infections in humans caused by contact with contaminated water or fish. It is only pathogenic to humans on abraded skin and has been associated with aquatic activities including fishing, keeping tropical fish and swimming. It has been found worldwide but is an increasing problem in south east Asia amongst fish farmers breeding tropical fish. A recent survey in Thailand found that 20% of Japanese fighting fish were infected (S.Adams *pers. comm.*). In humans it causes multiple granulomatous lesions and systemic arthritis. Treatment involves a combination antibiotic regime for at least 6 months and complete resolution may take several years (Edelstein 1994). Without treatment people may require surgery to remove the granulomas, which can lead to loss of limbs. This scale of medical treatment is often unavailable to the peri-urban fish farmers. Simple preventive measures such as the use of gloves, or at least the washing of skin after contact with fish water could reduce the incidence of infections considerably.

6-4.2 Non-communicable disease/injury

6.4.2.1 Contamination by industrial and agroindustrial wastes

- Water for aquaculture can be affected by a wide range of hazardous contaminants including industrial chemicals, trace metals, pesticides, disinfectants, viruses, bacteria, phycotoxins, antibiotics and hormones. Pollution particularly by industrial and agro-industrial wastes poses a serious constraint to the safe use of wastewater for aquaculture.
- There is little published data on the quantities of chemicals and drugs used in western aquaculture and even less is known about the types or quantities used in the tropics. Chemicals include compounds deliberately employed to improve productivity (lime, fertilisers), control pests or treat and control disease (pesticides, insecticides, herbicides, molluscicides, piscicides, parasiticides). The effects of many chemicals on the environment and human health are unknown. The lack of adequate information makes it difficult to determine whether a source of wastewater is appropriate for safe reuse in aquaculture. Those chemicals already known to be hazardous to human health include synthetic organic compounds such as polychlorinated biphenyls (PCB), petroleum hydrocarbons, pesticides and the heavy metals cadmium, lead, arsenic, mercury, selenium, tin and copper (Verlaan 1997). There is little information about chemical persistence and bio-accumulation.
- The few toxicological studies have addressed only short term fatal exposure. The greatest understanding of potential health risks often comes from studies of chemical contamination and food safety but this is non-predictive. There is a need for monitoring aquaculture water and fish products for toxic chemicals and trace metal contamination

- 4 The most common chemicals used in aquaculture today are formalin, potassium permanganate, diphterex and malachite green. Chemicals are added directly to the ponds and cause environmental contamination. The human health hazards are unclear.
5. Fish poisons such as phosgene producing chemicals are frequently used to harvest fish and are potentially lethal to people if wrongly handled.

6.4.2.2 Toxic algal bloom

1. Marine fish and shellfish are susceptible to contamination by natural toxins produced by some algae. The problem is most acute when algal blooms, referred to as "red tides" occur. Algal blooms are stimulated by sewerage discharges and agricultural runoff enriched in nutrients such as nitrogen and phosphorous. The problem is worldwide and associated with both fresh and sea waters (Dunlop 1991). Certain algae, dinoflagellates, that appear in red tides are harmful to human health. The algae kill fish and render molluscs and crustaceans toxic. Children are especially vulnerable because their toxic thresholds are very low. Some algae produce neurotoxins that can cause paralytic shellfish poisoning (PSP). PSP causes respiratory paralysis and death by asphyxia. Other dinoflagellates produce diarrhetic toxins that cause severe gastrointestinal disorders. Another group of dinoflagellates produce ciguatoxins that are concentrated in the food chain and cause ciguatera in humans eating contaminated fish (Verlaan 1997). Ciguatera has long term debilitating effects on neurological, cardiovascular and gastrointestinal functions. Fear of poisoning severely restricts fish exports from several island nations. Outbreaks also disrupt the tourist industry. Ciguatoxic biotopes can be created by development activities that disrupt reef systems. These include the construction of hotels, aircraft runways and wharves (Lewis 1986). In aquaculture developments and marine capture fisheries, monitoring of harmful algal species is crucial for public health purposes but should not replace concomitant testing of produce for biotoxins.

6.4.2.3 Occupational diseases

Processing of sea-food, particularly crabs, has been associated with increased prevalence of chronic obstructive airways disease among the workforce (Orford and Wilson 1985).

6.4.3 Malnutrition

1. Households in existing or potential fish-farming communities are often impoverished and dependent on variable resources. Aquaculture development can cause economic shifts or changes in access to resources that may disturb basic household nutrition, especially in areas where agricultural land is limited.
2. In Ecuador, large areas of mangrove forest along the coast have been destroyed as entrepreneurs have constructed saltwater fish ponds for shrimp farming. The displaced people have been marginalised and have lost their independent food security. For a while some worked on the fish farms but the source of fry from the sea became exhausted and the fish farms failed. Meanwhile the area is no longer capable of producing food for the indigenous population (Television Trust for the Environment 1992).

In river deltas, such as the Ganges and Brahmaputra in Bangladesh, annual flooding traditionally provides an opportunity for intensive fishing. The landless poor, in particular, derive a substantial part of their nutritional needs from their rights to fish the flooded lands. Development projects that are designed to restrict flooding can alter fish migratory routes and spawning grounds. Some common fisheries have also been taken over by commercial enterprises and stocked with exotic species such as carp, thus turning a capture fishery into a culture fishery. Both these projects reduce the access of the poor to this common nutritional resource (Birley, *pers.obs.*)

7. Livestock

7.1 Summary

Table 23 Summary of health linkages for livestock

Development Sub-category	Communicable diseases	Non-communicable diseases	Malnutrition	Injury
Live animals		Inhalation of dusts allergens	Loss of subsistence crops, loss of	Noise, attacks, falls, crushing
Slaughtering	Inhalation of dust	Inhalation of dust allergens		
Products	Unpasteurised dairy products, Consumption of meat		Loss of subsistence products	
Drug residues	misuse of antibiotics	Metabolites in products		
Animal feed contamination	Contamination by faeces of animal and animal products	Agro-chemicals and hazardous chemical contaminants of		
Wastes	Discharge into water supplies, application slurries to land, contact	Heavy metals in		
Tanneries	Handling infected	Exposure to a range process chemicals		Chemical burns, falls, machinery

- There are many diseases that can be transmitted from domestic animals to people during production, processing or consumption.
- Wastes from livestock production can contaminate drinking water with pathogens and chemicals. International trade in livestock can introduce exotic diseases.
- Allergens from livestock can cause occupational diseases.
- Loss of land to livestock can deprive poor people of food.
- Animals can injure people.
- Use of antibiotics in livestock rearing can be hazardous to human health. Resistant strains of bacteria can develop. drug residues are metabolised into many derivatives with unknown properties.
- Contaminants in feed can be transmitted via faeces or animal products.
- Tanneries use many hazardous chemicals and discharge them in wastes. There are also many occupational health and safety problems in tanneries.

7.2 Introduction

1. The FAO have a peri-urban livestock production system programme. The programme recognises a spectrum of production from intensive industrialised, through semi-intensive to subsistence (Bagust 1996). Many systems are characterised by:
 - scarcity of land for growing feed;
 - dependency on delivery of feed from outside;
 - utilisation of waste from households, restaurants, industry and crop residues;
 - animal scavenging.
2. The problem of unpened domestic animals wandering the streets and scavenging was also mentioned in a number of community surveys conducted as part of Healthy Cities Projects (Rice and Rasmusson 1992).
3. Veterinary public health hazards of major concern are zoonoses transmitted through direct contact during the production process or ingestion of contaminated products. Pathogens may spread through contaminated drinking water and transmission may be enhanced by high human and animal densities.

In 1996, FAO commissioned a case study in Ho Chi Minh city (Bagust 1996). The report concluded that the veterinary public health situation was precarious. Meat inspection and hygiene standards were compromised by large numbers of small "slaughter points". Some 20 significant zoonotic diseases were known to occur and these were listed. The most important were bovine tuberculosis, leptospirosis, rabies, trichinosis, bovine brucellosis and Taeniasis. Prevalence data was lacking. Potentially hazardous adulterants were quite commonly being added to meat to make it look fresh. There were a number of quality control mechanisms to ensure food safety and the associated operational problems were listed. There was a plan to relocate formal production and slaughter houses in the city to a central peri-urban area but the associated impacts did not seem to have been closely addressed. A policy of deregulation appeared to have been pursued in response to free market economics but without consideration of the health impacts - a good example of the need for prospective health impact assessment of government (or municipal) policy. Institutional problems included poor linkages between the Ministry of Health, Public Health Department, and Ministry of Agriculture, Veterinary Services Department. The major recommendations were to obtain better prevalence rate data for the most important zoonoses; to improve inter-sectoral linkages; and proper impact planning of the relocated industries.

1. In contrast to the FAO project, NRI's own peri-urban livestock production project does not appear to focus on animal health or veterinary public health (Silverside et al. 1996) although the Renewable Natural Resources Strategy as a whole has both an animal health and livestock production programme
2. Table 24, derived from an early USAID report is an early attempt to compare some of the positive and negative health impacts of livestock development.

Table 24 Potential positive and negative health impacts of livestock development (modified from USAID (Family Health Care Inc./USAID 1979).

ACTIVITY	POSITIVE EFFECTS	NEGATIVE EFFECTS
Animal health: vaccination programs, dipping tanks, disease control.	Increased availability of high quality protein in the market area improving human nutrition, animal health, marketability.	Increased pressure on range resources, potential overgrazing, loss of ground cover. Improper use of chemicals, concentration of toxic substances in water, soil, food.
Livestock water supply.	Increased herd size and number as water supply constraints ease, increased livestock survivorship. Improved animal health.	Increased pressure on range resources (expanded potential for overgrazing and subsequent decline of soil fertility).
Establishment of markets, slaughterhouses, storage and shipping facilities.	Increased availability of high-quality protein in market area, improved nutrition, increased resistance to disease. Attraction of merchants, more available cash, increased availability of commercial goods and services. Improved efficiency of livestock marketing. Decrease in livestock disease due to dipping in disinfectant.	Increase in zoonotic diseases due to meat processing: anthrax; brucellosis; bovine tuberculosis; cattle trypanosomiasis. Possible contamination of food and water supply. Overuse of sanitation facilities due to increased immigration: increase in food and water-borne diseases (dysenteries, typhoid, cholera, intestinal worms); increase in vector-borne diseases (malaria, schistosomiasis, trypanosomiasis).

7.3 Communicable disease: zoonoses

1. Several communicable diseases can be increased by the importation of exotic breeds of livestock or the intensification of livestock production. Three important bacterial zoonoses are anthrax, brucellosis and bovine tuberculosis. All are carried primarily by cattle although they can be transmitted by a variety of animal hosts including pigs, goats, dogs and wild animal species. The rate of infection in humans is directly correlated with the incidence of disease in domestic animals.
2. Worldwide there are over half a million cases of brucellosis in humans annually (Acha and Szyfres 1987). Human infection occurs via the ingestion of contaminated unpasteurised dairy products or following direct contact with infected animal material (blood, urine) and is an occupational hazard of livestock and slaughterhouse workers. Epidemiological evidence also suggests that brucellosis can spread by airborne transmission and inhalation. A high rate of infection was found in people that worked in areas surrounding slaughterhouses where the killing areas were not separate (Acha and Szyfres 1987) In humans it can cause chronic, undulating fever and symptoms of generalised malaise which may persist for months or years with frequent recurrences. In areas where pastoralism is common many hospital patients who are treated for malaria or typhoid fever may actually have brucellosis. It can be cured with antibiotics in about 80% of cases but untreated it can cause death in 2% of cases (Bell et al. 1988). Programmes for control and eradication of brucellosis from animal reservoirs markedly decrease the incidence of disease in humans (Acha and Szyfres 1987). Uncontrolled livestock movement in urban areas is of particular concern for brucellosis control. Other prevention strategies require the heat-treating of all milk and dairy products, and good personal hygiene of

livestock and abattoir worker. Such measures are rarely maintained in developing countries. Of equal importance is the reduced protein supply due to livestock losses. Potential and future supplies of milk and meat are lost through abortion or calf deaths from infected animals. It has been estimated that such losses translate into a potential 12% decrease in the supply of milk and meat in many developing countries with a corresponding increase in the cost of milk and meat (Metcalf et al. 1994).

3. Human infection with bovine tuberculosis is a problem where the prevalence of infection in cattle is high. It is usually transmitted to humans by drinking untreated milk from infected cows. It causes symptoms similar to the more common human respiratory tuberculosis. This is a slow, progressive disease which can lead to recurrences and death if untreated (Bell et al. 1988). Long term, combination antibiotic treatment has to be taken for 6 months to ensure a cure, these drugs are often unobtainable or too expensive to many in developing countries. Preventive measures mainly involve heat-treating all milk. In Peru bovine tuberculosis accounts for over 4% of all tuberculosis in humans (Acha and Szyfres 1987). It is thought to be an increasing human disease problem in Africa where the spread of the human immunodeficiency virus (HIV) is associated with a greatly increased risk of tuberculosis in humans due to *Mycobacterium bovis* infection. In rural Zambia, 8% of all cattle were found to be seropositive for *Mycobacterium bovis*. People suffering from tuberculosis were found to be six times more likely to live in households keeping infected cattle (Cook et al. 1996). The difficulties in controlling spread of bovine tuberculosis will be even greater in urban and peri-urban areas where animals wander the streets uncontrolled. Eradication is not feasible in some countries with endemically infected wildlife which constantly reinfect domestic animals. Control measures must be applied indefinitely or alternatively public health programmes could aim for protection by vaccination of the human population. Both these solutions require widespread, thorough public health programmes to ensure adequate control is achieved and will prove expensive, thus increasing costs of both milk and meat.
4. Anthrax is most common in people who work with livestock, eat insufficiently cooked meat from infected animals or work in animal product industries including processing of wool and animal skins. Anthrax is found worldwide but it is endemic in Africa, South East Asia and parts of Central and South America. There are three forms of human infection: cutaneous anthrax occurs when the infection enters through a cut on the skin, respiratory anthrax occurs when the bacterial spores are inhaled, and intestinal anthrax results from the ingestion of contaminated animal products. They can be successfully treated with antibiotics but untreated there is a very high and rapid fatality rate (5-75%). Anthrax is controlled by preventing human contact with infected animals and their products, and excluding contaminated carcasses from the food chain. A simple laboratory antigen test can be used to investigate animal products suspected of being infected (including hides). However, this procedure is not often available, especially in many slaughterhouses. Environmental and personal hygiene measures, such as ventilation and protective clothing, can reduce the occupational hazards of livestock and workers in animal product industries. Vaccination may be used to protect those at high occupational risk, animals grazing in endemic areas can also be vaccinated. Anthrax spores can remain viable in the natural environment and in animal products for long periods although the actual time of latency is unclear. As a precaution wool and fur should be disinfected. For this reason anthrax has been considered a potential biological warfare agent, for example during the Gulf War in 1990-91 (Whitford and Hugh-Jones 1994).
5. Q fever is emerging as a public health problem in areas of sheep, cattle rearing and dairy farms (Lang 1989). Human infection is usually through inhalation and abattoir workers are especially at risk (Sawyer et al 1987; Somma-ivloreira et al. 1987). After a human epidemic in the Cape Verde islands some 60% of animal sera were seropositive for Q Fever (Sixl and Sixl-Voigt 1987).
6. Increased international trade in livestock is distributing zoonoses to new areas. For example, in 1971 domestic pigs were imported into West New Guinea from a country in which cysticercosis (due to *Taenia solium*) was endemic in pigs and people. The parasite had been previously absent from New Guinea. In 1974 there was an epidemic of severe burns among the Ekari people which was attributed to epileptic fits causing people to fall into fires. The fits were correlated with cerebral cysticercosis infection. The infection spread rapidly and was difficult to control due to husbandry practices and this is believed to have caused considerable economic loss (Gunawan et al. 1976; Gajdusek 1978). The present global distribution of cystic hydatid disease (due to *Echinococcus granulosus*) is associated with the widespread importation of sheep and dogs (Thompson 1979). Trichinosis in Africa is of rare human importance and caused by a strain of parasite which is not well adapted to domestic pigs. There is concern that new strains may be introduced via imported pigs from regions where it is of considerably greater importance (Campbell 1991).
7. Leptospirosis or Weil's disease is transmitted by infected animal urine. Humans are infected by contact with the animal or affected environment, for example by handling contaminated feedstuffs and cereals, or swimming

in or drinking contaminated water supplies (Rainbird and O'Neill 1993) In Africa and India Weil's disease is fatal over 20% of cases

8. For a more detailed discussion of zoonoses see Beran (1994) and Bell (1988).

7.4 Non-communicable disease

1. Animal husbandry may entail exposure to a number of non-communicable diseases. These include asthma and allergic pneumonitis amongst those exposed to animal wastes, and occupational asthma, for example amongst those working with poultry. Noise may also be a substantial problem, for example amongst those working in chicken batteries.
2. Dairy farming has been associated with increased prevalence of farmer's lung disease. This is due to working long hours in enclosed spaces exposed to organic particulate matter. In the US, deaths due to farmer's lung disease are more common in the dairy industry than in other kinds of farming (Mannino et al. 1990).

7.5 Malnutrition

1. There is a general concern about the replacement of large areas of crop production by commercial livestock production. Livestock are inefficient at converting biomass to food compared with crops (Pimental and Pimental 1979). A unit of good agricultural land can support more people through the production of crops for human consumption than through livestock production. Often the direct nutritional benefits of commercial livestock production are not felt by the people in the producing areas.
2. For example, in Mexico, livestock grain consumption changed from 6% to 50% between 1960 and 1985. In 1985, 25 million Mexicans were too poor to eat meat. The land planted to subsistence crops did not increase during the same period. The area planted for sorghum, a cattle feed, increased dramatically (Lappe and Collins 1988). During the 1960s, soybean became an important crop in Brazil. By the end of the 1970s it was the country's biggest export - all going to feed Japanese and European livestock. At the same time the number of people suffering from hunger rose from one-third of the population in 1960 to two-thirds by the *early* 1980s (Lappe and Collins 1988).
3. In many parts of Africa women care for dairy cattle. Their investment of time and other resources has to be increased for supplying commercial dairies often at the expense of other food producing tasks. However, the dairies usually pay cash to the men. Women have increased their labour but lost an income source from occasional sales of milk and milk products (Food and Agriculture Organization 1984). The loss of cash income by women may lead to a reduction in family nutrition, as male priorities may be different.

7.6 Injury

Caring for animals poses a number of potential injury hazards including animal bites, being gored by horns (e.g. by goats and cows), lacerations, cuts and fractures from kicks, falls from animals and crush injuries.

7.7 Drug residues

7.7.1 Communicable disease

in some countries large proportions of livestock receive drugs for therapy, prophylaxis or growth promotion. For example, chickens grow 10% faster when fed on antibiotics. Sub-therapeutic doses of antibiotic in the animal body and residues in the environment facilitate the development of resistant strains of bacteria, including *Salmonella* (Yndestad 1991). A study in Alma Ata, Kazakhstan suggested that *Salmonella* species isolated from poultry farm employees, shepherds, animals and fowls featured multiple antibiotic resistance, especially to the tetracycline family. This was possibly due to veterinary applications of antibiotics not only for treatment and prevention but also as food supplements (Kotova et al. 1988). In the USA, an outbreak of salmonellosis resistant to many antibiotics was traced to hamburgers derived from antibiotic treated cattle (Conway and Pretty 1991).

7.7.2 Non-communicable disease

1. When drugs are used in livestock the possibility exists that residues will occur in human food products. The parent drug is metabolised by the animal into many derivatives (Cravedi 1991). The maximum acceptable daily intake of either parent drug or derivatives has not always been established. Some of the drugs have known teratogenic potential. In Norway about twice as many antibiotics are consumed by animals and fish as by humans (Yndestad 1991). In India about 80% of the animal production industry uses antibiotics and other drugs (Singh and Vijan 1987).

7.8 Animal feed contamination

7.8.9 Communicable disease

1. Animal feeds composed of meals partly of animal and partly of vegetable origin have shown to be contaminated with *Salmonella* and *Campylobacter*. Animals fed on such feeds in intensive breeding units shed large quantities of pathogens in their faeces that contaminate the wet surfaces of slaughter houses, meat processing and distribution plants. The large numbers of these carrier animals have contributed to the contamination of the environment and to the creation of infection cycles of foodborne diseases (World Health Organization Commission on Health and Environment 1992b). For example, in 1985 some 200,000 people were involved in an outbreak of salmonellosis in Chicago caused by consuming contaminated pasteurised milk (Ryan et al. 1987). In 1989, the UK reported about 32,000 cases of Campylobacteriosis, a leading cause of foodborne disease (Public Health Laboratory Services 1989).
2. More recent concerns in the UK have focused on the role of contaminated animal feed in the spread of bovine spongiform encephalopathy (BSE) in cows. Brain and spinal cord from infected cows was incorporated into cattle feed in the 1980's and has been considered responsible for the continued spread of BSE in British cattle, and the potential risk of its transmission through the food chain to humans. It is not known if this is a problem in other countries.

7.8.2 Non-communicable disease

1. The presence of residues of pesticides, herbicides, fumigants and heavy metals in livestock because of contaminated feeds is of potential health importance (Cordle 1988; Vreman et al. 1988).

7.9 Livestock wastes

7.9.1 Communicable disease

1. Livestock waste is increasingly discharged into rivers, rendering them hazardous as water sources. It is also used as fertiliser for field crops, vegetable gardens and fish ponds. Parasites are spread from the waste to people who handle fish and prepare or consume raw food. Slurry disbursed on land in hot climates aids the rapid growth of pathogens responsible for foot-and-mouth disease, tuberculosis and brucellosis.
1. Cryptosporidial infection is an emerging cause of diarrhoea among children and immuno-suppressed adults (Rush 1987; Wittenberg et al. 1987). Contamination of drinking water with animal faecal matter is an important source of infection.
3. Contact with poultry and an environment contaminated with animal faecal matter increases the transmission of *Salmonella* and *Campylobacter* to humans (Grados et al. 1988, Moelbak et al. 1988). The wastewater discharges from poultry farms can carry heavy loads of these micro-organisms and may contaminate drinking water supplies (Stelzer et al. 1988). For example, abattoir workers in Holland associated with the pork industry have a 1500 times higher chance of getting meningitis associated with *Salmonella* infection than other workers (Arends and Zanen 1988). A study in Alma Ata, Kazakhstan, found that in industrial poultry farms, 16% of hens and 12% of ducks were infected with *Salmonella*. The study established that humans develop the *Salmonella* carrier state as a result of occupational exposure to poultry and rams (Kotova et al. 1988).

7.9.2 Non-communicable disease

1. Heavy metals in slurry may be absorbed by vegetables and consumed by humans.

7.10 Tanneries

1. Tanneries are an important example of industrial processing of a natural resource that takes place in peri-urban areas, uses hazardous chemicals and produces hazardous wastes.
2. About 250 chemicals are used in tanneries including tannin, chromium and alum as well as other acids, alkalis, solvents, oils, finishes and dyes. Materials that can appear in tannery wastes include: hair, hide scraps, pieces of flesh, blood, manure, dirt, salts, lime, soluble proteins, sulphides, amines, chromium salts, tannin, soda ash, sugars and starches, oils, fats, greases, surface agents, mineral acids, dyes and solvents. Some of these are hazardous to health.
3. Particulate matters and hydrogen sulphide are the two potential gaseous discharges of significance (The World Bank 1988a). Air pollution is mainly caused by the discharge of chemicals associated with unhairing liquid and pickling operations. A study monitoring air pollution in the residential area of Chiampo Valley in northern Italy, where about 150 tanneries are located, found that the highest concentration of hydrogen sulphide was detected within 1 kilometre downwind of 40 tanneries (Cocheo 1990).
4. Measures for control and treatment of wastes are available. Shavings produced when processing hides into leather can be treated to extract the chromium contents for recycling. This leaves a waste by-product which

can be used as glue, animal *food* or fertiliser for non-edible crops. However most of these measures and regulations regarding the disposal of waste are ignored, and most wastes are just dumped in the environment especially in developing countries (Dodangoda 1992).

7.10.1 Communicable disease

1. The main communicable health hazard of the leather industry is anthrax.

7.10.2 Non-communicable disease

1. The main non-communicable health hazard of the leather industry is dermatitis from contacts with chemicals and hides. Chromium can cause indolent and painful chrome ulcers of the skin and nasal septum in addition to dermatitis. Other significant hazards associated with the leather industry include exposure to excessive dust, toxic chemicals, noise and reproductive hazards (Marinova 1978). For example, in Jajmau, an industrial slum of Kanpur in India, occupational morbidity was 28% among tannery workers (Shukla et al. 1991). A study of 252,147 live birth babies delivered in Scotland between 1981-1984 found that women who worked in leather had rates of pre-term delivery and low birth weight which were 50% higher than in most other female manual workers (Sanjose et al. 1991). In Montreal, Canada, a survey of pregnancy in leather workers found a significant excess of stillbirths (McDonald and McDonald 1986).
2. Dust, produced in many leather working processes may be responsible for causing chronic bronchitis (The World Bank 1988b). Asthma causing agents used in tanning include casein, chromium salts, paraphenylenediamine and formaldehyde (Olaguibel et al. 1990).
3. Hydrogen sulphide gas is released through mixing of sulphides and chromic acid. Though such contact is avoidable, fatal incidents have occurred (The World Bank 1988b). A number of substances used in the leather industry, such as azo dyes and chromium, are genotoxic leading to mutagenic and carcinogenic effects (Marinova 1978; Clonfero et al. 1990a; Clonfero et al. 1990b; Dodangoda 1992). Exposure to atmospheric chromate may cause bronchogenic carcinoma with a latent period of 10-15 years (Dodangoda 1992). Excess level of bladder, nasal, laryngeal and lung cancer and leukaemia have been reported in leather workers in several countries (Seniori Costantini et al. 1990; Ahrens et al. 1991; Yamaguchi et al. 1991).

7.10.3 Injury

The major injuries are caused by machinery, falls on slippery floors, and chemical burns from acid, alkalis and chromic acid. Both injury and illness rates are considerably higher in the tannery industry than the average for all other industries. In the USA, in 1975, leather tanning and finishing workers had an incidence rate of 20.9 total injuries per 100 full time workers against an incidence rate of 12.5 total injuries in this category for all manufacturing workers (time unit not cited). In the category of occupational illnesses, the incidence rate per 100 full time workers was 2.4 for leather tanning and finishing workers, against an incidence rate of 0.5 for all manufacturing workers (The World Bank 1988b).

8. Recycling and waste reuse

8.1 Summary

Table 25 Summary of health linkages for recycling and waste reuse

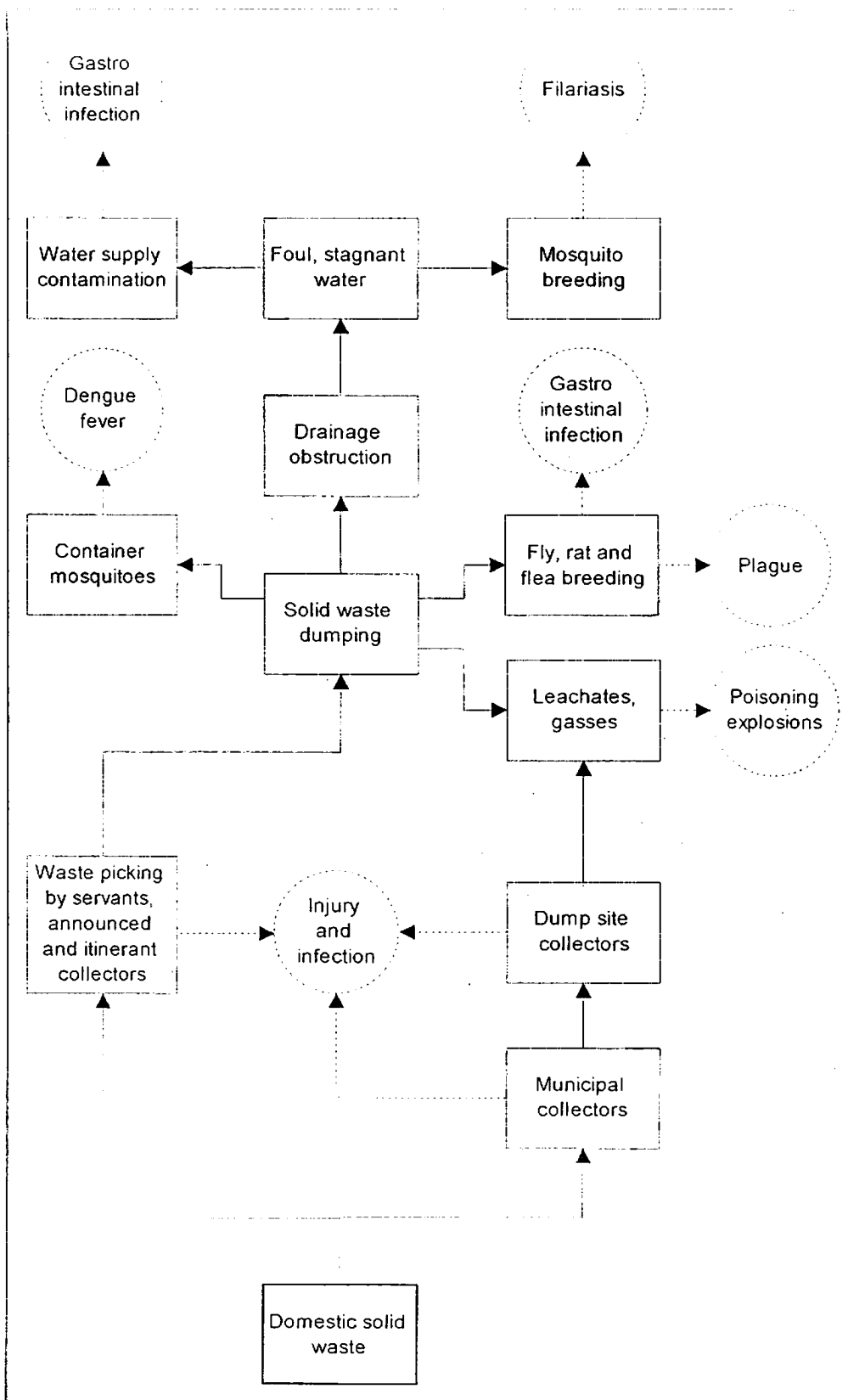
Development Sub-category	Communicable diseases	Non-communicable diseases	Malnutrition	Injury
Solid wastes	Attraction of rodents, poor composting, poor refuse disposal, lack of when handling, smoke dust, vector breeding sites	Accumulation of hazardous chemicals, smoke and dust, leachates, skin contact when sorting .		Cutting and piercing injuries during sorting, combustible gasses
Fertiliser, soil ameliorant, animal feed	Poor composting, poor refuse disposal, vector breeding sites	Accumulation of hazardous chemicals, plant uptake, leachates		Cutting and piercing injuries during sorting
Liquid waste	Level of treatment, retention time of sewage waste, contamination of drinking supplies, occupational exposure	Mixing of domestic and industrial wastes, contamination of drinking supplies including groundwater, plant uptake, chlorination		
Sludge	Poor composting, vector breeding sites	plant uptake, groundwater contamination		

- Waste pickers make a substantial contribution to solid waste management but are poorly protected from injury, infection and abuse.
- Poor quality composting may not destroy pathogens such as nematode eggs.
- Mixture of organic and inorganic materials, including sharps, in compost may transfer hazardous chemicals to the food chain and occupational injuries to workers.
- Poor solid waste management creates breeding sites for mosquito vectors of dengue and filariasis, house fly vectors of various pathogens, rodents and rodent fleas.
- Animal scavenging of waste tips may facilitate zoonotic disease transmission.
- Leachates from waste tips pollute drinking water sources and there is a risk of explosion from methane production.
- There are many pathogens potentially transmitted by contact with and use of domestic sewage.
- There are international wastewater treatment standards based on faecal coliforms and nematode eggs. U industrial effluents can contain many hazardous chemicals and some of these are rendered more toxic by chlorination.
- Drinking water contamination with nitrates is potentially hazardous for infants.
- Wastewater is safe to reuse if a series of barriers to infection are established. These include choice of crop, choice of irrigation method and crop certification.

8.2 Solid waste

1. Infrequent collection and rapid decomposition of wastes provide an attractive feeding, and breeding site for flies, rats and other scavengers. Human and animal faecal matter or hospital wastes are often mixed with the refuse causing a site tier vectors and pathogens to breed. Domestic, and on occasion industrial, solid wastes are disposed of in open spaces within residential areas (World Health Organization Commission on Health and Environment 1992x).
1. Figure 3 is an overview of some solid waste management and health linkages.
2. The provision of the hardware for waste removal is similar in rural and urban areas but there are differences in the software required for delivering and maintaining the inputs because of differences in people's priorities, financial circumstances and organizations (Atkinson and Merkle 1993). In Cucuta, Columbia, a low-income area tackled its solid waste problem by establishing micro-enterprises. After training in business skills, local residents bid and were contracted to collect and transport solid waste within defined areas and to a defined landfill site. Three micro-enterprises provided twice weekly house collections for 150,000 inhabitants (Atkinson and Merkle 1993). A similar system in Windhoek, Namibia, had 72 contractors with costs 40% lower than a truck based system and facilitated sorting and recycling of waste. Close supervision was required to regulate the contractors activities (Atkinson and Merkle 1993).

Figure 3 Some solid waste - health linkages



1. A recent World Bank note advocates the use of composted urban waste in peri-urban agriculture (Schillhorn and O'Connell 1997). Of particular interest is the identification of policy level changes needed to facilitate such use. These include the need for multi-sectoral frameworks and dialogues, improved links between waste management and agriculture and well defined priorities and strategies that recognise the

need to protect human health. One successful scheme cited was a project to produce commercial compost from a Senegalese abattoir's waste.

2. EHP have an active interest in urban solid waste management and the results of their activities are described in a recent newsletter (Environmental Health Programme 1996). The newsletter draws articles from a number of networked institutions, including WEDC in Loughborough. It reports experience in the development of micro-enterprises. The health problems associated with solid waste are reviewed but the reuse of solid waste in natural resource development is not discussed.
3. Collection and disposal of refuse can consume up to 50% of a municipal operating budget. In many otherwise good systems, only 50-70% of the refuse is regularly collected. The problem is organizational rather than technical. Refuse disposal is often a non-profit making business and thus is treated as an unwanted side-effect of development. Attention should be paid to storage, collection, transport, intermediate transfer to bulk transport and final disposal.
4. Where markets for solid waste exist there is usually a thriving trade which supports many destitute people. The market chain has been described in some detail (Furedy 1990b; Furedy 1990a; Furedy 1994; Furedy 1996). It includes the scavengers, domestic servants, municipal collectors, sorters, separators, purchasers with weighing scales, middle men with trucks and end users in both informal and formal industrial sectors. UNCHS have produced a video that illustrates these processes. In some regions waste recovery is an important private industry employing many thousands of scavengers or waste pickers who may live or work on refuse dumps. They are frequently ignored in urban project plans although their activities may be vital to the life of the city. Many consist of abandoned children and destitute families. They live and work under extensive health risks, which are largely undocumented, and suffer severe exploitation and deprivation. Suggested health hazards include raised levels of infant mortality, hand and leg injuries, intestinal and respiratory infections, eye infections, lower back pain, malnutrition, skin disorders and exposure to hazardous waste (Adan et al. 1982, Bubel 1990). Water supply, for drinking and washing, and sanitation facilities are usually very poor at dump sites. Health and welfare facilities are required.
5. Mexico City has 10,000 scavengers of the city dump. Cairo has 16,000 traditional refuse collectors who recycle nearly half of the 5,000 tonnes of daily waste (Jensen 1990). The total number of people in Asian cities whose occupation consists of waste recovery and recycling is believed to be several million and growing (Bubel 1990; Furedy 1990b). Some 1-2% of the urban population may be so employed. More than 14,000 people were said to live and work on "Smokey Mountain", one of Manila's dumpsites. Jakarta may have over 12,000 waste pickers. More than 40,000 people may gain their livelihood from waste in Calcutta (Bubel 1990).
6. Waste pickers may make a substantial contribution to urban waste management. They may reduce the volume of waste by 10-20%. However, private collection at source may only operate in the wealthy areas where refuse contains items of value. Observers agree that the issue of waste pickers cannot be evaded. Their positive role in the management of urban solid waste should be recognised and their lot improved (Furedy 1990b). Legislation against waste pickers is no solution.
7. Furedy notes that there is now a global philosophy of solid waste management based on waste minimisation, recovery and recycling (Furedy 1994). This has provided a basis for inter-sectoral partnerships to solve the crisis of increasing refuse and inadequate infrastructure. Furedy surveyed research activities and noted that they focused on waste picking and the welfare of waste pickers including street children. She noted that there were many projects to assist waste pickers and those that seemed more successful shifted the activity away from dump sites and closer to the source of the waste. Another approach is to assist waste pickers at the same time as encouraging them to find other employment: waste picking persists but as a temporary employment for individuals and its detrimental effects are reduced.
8. A study by Hunt (1996) examined the medical condition of waste picking and non-waste picking children in India. Rates of intestinal worm infection, scabies and upper respiratory tract infection were higher amongst waste pickers.
9. A consultative meeting on "recycling waste for agriculture the rural-urban connection" was held at the World Bank in 1996 (Furedy unpubl). Health issues were discussed including disposal of animal wastes from slaughterhouses, composting mixed waste, removing inorganics and the potential health hazards; composting human excreta from latrines; and the need for quality standards for municipal solid waste streams and composts produced from them.
10. Furedy notes the convergence of urban agriculture and waste reuse concerns through composting for agricultural fertiliser/soil conditioner and feeding food wastes to livestock (Furedy 1996). Tensions occur

From slaughter houses, composting mixed waste, removing inorganics and the potential health hazards, composting human excreta from latrines, and the need for quality standards for municipal solid waste streams and composts produced from them.

- Furedy notes the convergence of urban agriculture and waste reuse concerns through composting for agricultural fertiliser/soil conditioner and feeding food wastes to livestock (Furedy 1996). Tensions occur between public health and urban agriculture specialists because of concerns about communicable diseases, zoonoses and injuries on the one hand versus increased food production and job creation on the other. Furedy suggests that the hazards associated with excreta and wastewater have been well researched compared to the hazards associated with solid waste. She suggests the typology in Table 26.

Table 26, Organic waste reuse and hazards (modified from Furedy, 1996)

Type of waste reuse	Health hazards
Kitchen, restaurant and canteen vegetable waste	Fed to livestock, probably low risk of communicable disease.
Regular mixed municipal including organic inorganics, biomedical and	Applied to soil without adequate composting and separation there communicable disease, non-communicable disease and injury
Kitchen and yard wastes, composted backyard	Could pesticide residues accumulate?
Community compost heaps	Poor quality control of separation of organic and inorganics, attraction of which may be disease reservoirs and insects which may be mechanical
Mixed municipal waste delivered to composting plants	Product contains glass splinters and heavy metals. Pesticide residues Most facilities have failed to operate.
Kitchen and yard wastes delivered to centralised composting plants	Low temperature composting may not destroy pathogens.
Old garbage dumps used for	Injuries from sharps, respiratory problems from dust, concerns about of industrial waste.
Mining of old garbage dumps for compost	Injuries from sharps, respiratory problems from dust, concerns about of industrial waste.
Cowdung	Lack of hand washing facilities.

8.2.1 Fertiliser, soil ameliorant and animal feeds

- One of the three main purposes of the Natural Resources Systems Programme Peri-urban Interface Production *System* is recycling/processing *organic waste for use as a fertiliser, soil ameliorants, or feeds*. A review of the use of peri-urban waste in peri-urban interface production systems was commissioned (Allison and Harris 1996). One conclusion of the review was that there have been few studies of the use of organic wastes in existing urban and peri-urban agricultural systems. The report recommended research into baseline studies of current use of urban organic wastes, assessment of the value of available waste materials, the efficacy and potential of small-scale on-farm methods of composting.
- The main use of the solid waste is as a soil improver but other uses include feed for livestock and fish. The most successful suppliers appear to be small private traders. The range of wastes used as animal and fish feeds includes animal wastes, agro-industrial wastes such as cereals, fruit, sugar, fish, meat and poultry; and municipal wastes such as paper. The range of waste used for soil ameliorants include sewerage, nightsoil, manure, fish wastes, and agro-industrial wastes.
- The use of waste for animal feed was thought to be constrained by:
 - the need to ensure a balanced and non-toxic diet;
 - variable and unreliable availability;
 - perishable nature of suitable waste;
 - processing requirements;
 - risk of introducing diseases into the food chain.
- Composting is the most common form of processing organic waste for use as soil improver. There are 3 health issues discussed in the literature with respect to composting:
 - heavy metal contamination,
 - pathogens,
 - safety from non-biodegradable fragments.
- Composting has the positive health benefit of sanitising waste by heat destruction of pathogens including helminth eggs found in nightsoil. However, this is only successful if high temperature composting is used or waste is stored for periods of about one year. Composting of waste at lower temperatures and shorter periods is common and does not destroy helminth eggs. Introduction of heavy metals into the food chain

Via compost should be minimized. This does not mean that the compost cannot contain heavy metals since many are essential for proper plant nutrition and do not pose a threat to human health at low concentrations. There are several guidelines for compost worldwide but most appear to be for use in the developed world. For example, CCME guidelines and NSDOE sludge and compost guidelines all present classification standards recommending heavy metal and pathogen levels for different compost uses (Nova Scotia Environmental Industry Association 1997). The Compost Analysis and Testing Scheme (CATS) developed by the Henry Doubleday Research association is a quality assurance service for large scale UK composters to ensure that the compost is safe for people using it, safe for the environment and for plants. With respect to human health issues they look at non-biodegradable fragments and pathogens (G. Smith *pers. comm.*).

6. Most composting initiatives reported in the literature are large scale, single plant initiatives rather than decentralised low technology programmes. Small composting plants in Accra are said to have failed as a result of lack of markets, lack of resources to subsidise production, and being located too far from the district served. In India composting plants in major cities have closed due to high costs. There are examples of successful, localised, low technology projects in Cairo, Kano, Nigeria and Mali (Allison and Harris 1996)
7. Nightsoil and sewage are widely used in agriculture in China and are usually processed by mixed composting, production of dry fertiliser, or covered storage. In Asia all types of waste are used for agriculture including city refuse, untreated sewage, composted plant residues and manure. In Cairo, there is extensive non-municipal waste collection and recycling. The rubbish is sorted by women and children. Organic material is fed to pigs. Pig manure and domestic waste is composted and supplied to farmers. In Thies, Senegal, untreated household rubbish from city dumps is used without sorting non-biodegradable items. In Kano, untreated sewage is mixed with organic household refuse. In Ghana, agricultural by-products are increasingly being used for compost.

8.2.2 Communicable diseases

1. A South African study of household risk factors for diarrhoea in peri-urban areas identified not owning a refuse receptacle as a significant factor (Atkinson and Merkle 1993).
2. Solid inorganic waste is a serious problems in many urban areas because of inefficient waste collection systems. Such waste provides a receptacle for rainwater and hence a breeding site for *Aedes* mosquitoes, vectors of dengue. Waste also accumulates in drains and creates pools of stagnant, organically polluted water which provides a breeding place for *Culex* mosquitoes that transmit filariasis in some regions.
3. Houseflies may be important in the transmission of enteric infections, particularly those responsible for infantile diarrhoea and dysenteries. Disease transmission by houseflies is greatest where inadequate refuse storage, collection and disposal (leading to increased breeding) is accompanied by inadequate sanitation. Thus flies gain greater access to human faeces. Refuse must be collected twice per week to prevent fly breeding. The role of houseflies in disease transmission has been shown in Palestinian refugee camps, where the breakdown of chemical control of flies led to dramatic increases in infantile diarrhoea (West 1953; Keiding 1964). Experimental trials using chemical control methods in Texas and Georgia demonstrated that diarrhoea attack rates may be up to 33% higher when houseflies are uncontrolled. Prevalence of the dysentery organism, *Shigella*, was three-fold higher in untreated areas whilst death rates from diarrhoea and dysentery were measurably greater where houseflies remained uncontrolled (Watt and Lindsay 1948, Lindsay et al. 1953). A similar result has recently been demonstrated with *non-Shigella* diarrhoea in Pakistan (D. Chavasseper.v. *comm.*).
4. Domestic rats, birds and other scavenging, animals act as reservoirs for many organisms transmissible to people, including plague, forms of typhus, leptospirosis, trichinosis, psittacosis and salmonella infection. Chemical control of both houseflies and rodents is not very effective because of widespread resistance. The essential basis of control remains denial of access to food and harbourage, by covered storage and efficient removal.

8.2.3 Non-communicable diseases

1. Once collected in poorly designed or poorly operated disposal sites, rubbish may contaminate groundwater with nitrates, heavy metals and other chemicals. Incineration of wastes may pollute the air with particulates and oxides of sulphur and nitrogen. The slag and ashes from incinerators may result in leachates that are rich in heavy metals and other potentially toxic substances (World Health Organization 1985).
2. Urban solid wastes are a source of essential plant nutrients and are used in agriculture. A survey in India on the impact of urban solid waste on plant uptake of heavy metals revealed that the heavy metal content varied between plant species. The elevated levels of zinc, copper, lead and nickel found in many of the

crops may prove phytotoxic and hazardous in the food chain (Jeevan Rao and Shantaran 1995) Allison and Harris (1996) cite evidence by Drescher (1994) from Lusaka indicating that the vegetables growing on urban landfill sites did not accumulate heavy metals. There is particular concern about common brassica crops, See also *bioaccumulation of pollutants* p45.

3. No evidence of heavy metal limits was found in FAO documentation. Further research is needed to establish the safe heavy metal content of solid waste used for fertiliser.

8.2.4 Injury

1. Combustible gases will be generated from waste tips for more than 20 years and these travel under roads and through ducts to create a hazard in buildings. In Turkey, April 1993, methane from a rubbish tip exploded killing at least 13, injuring 100 and destroying homes (Associated Press 1993).
2. People collecting and sorting rubbish may be injured by sharp objects including glass, metal and wood. These may lead to puncture wounds and lacerations which may become infected and cause serious morbidity. Composted solid waste can cause injury to farmers as sharp objects are not always properly removed (Nicolaisen et al. 1988). Other hazardous materials in solid waste include biomedical and toxic substances.

8.2.5 Assessment of health risks

1. Furedy points out that official attitudes towards the health risks associated with solid waste have historically changed with necessity (Furedy 1996). She asks, in effect, whether the perceived health risks are overstated. In order to analyse the problem further she identifies the vulnerable communities, the environmental factors and the institutional response, as follows.

8.2.5.1 The vulnerable communities

1. An analysis of the health risks associated with solid waste reuse should identify the vulnerable communities. These include:
 - waste workers;
 - infants and children of waste workers and peripheral communities;
 - farmers;
 - peripheral communities to large waste processing plants;
 - consumers of plants grown with the compost';
 - consumers of animals fed on the wastes;
 - consumers of water polluted with leachates,
 - food handlers;
 - owners of livestock fed or grazed on the waste.
2. The host risk factors that determine the vulnerability of these communities include poverty, age, gender, education and behaviour.

8.2.5.2 The environmental risk factors

1. The environmental risk factors determine how vulnerable communities are exposed to the health hazards associated with solid waste. These include:
 - the waste materials, their source and mix, their rodent and vector community;
 - the survival time of pathogens in the waste;
 - methods of application and use;
 - livestock characteristics and exposure including the prevalence rate of parasites,
 - site characteristics such as aquifers, leaching, availability of sanitation.
2. Furedy suggests that principles similar to those applied in safe wastewater reuse could be applied to safe solid waste reuse, such as establishing a series of barriers to exposure. She also suggests that where multiple routes of exposure to infection already exist, occupational exposure to waste may not add a significant risk. However, this would depend on the latency and persistence of the infectious agent. As an example, she suggests that the barriers to exposure in community composting depend on (my paraphrasing):
 - thoroughness of separation of materials at source, especially sharps;
 - quality of the composting process, which may not destroy pathogens;
 - general health of the waste generators;
 - immune status of the consumers;
 - risk of accumulation of hazardous chemicals including pesticides.

8.2.5.3 Institutional factors

1. Municipal authorities cite health risks inappropriately as a reason to restrict urban agriculture. Regulations are frequently outdated, or lack comprehensiveness. For example, hazardous chemicals may not be included or consumer but not workers safety may be considered. Enforcement of regulations is also haphazard.
2. Furedy notes that the proponents of urban agriculture have said remarkably little about health hazards. There has been little systematic thinking. For example, she cites a 1993 IDRC request for research proposals linking urban agriculture and health for which none were provided. She suggests that one of the reasons for the absence of systemic thinking is a lack of intersectoral linkage between health and agricultural research networks. She suggests several solutions, including health impact assessment and epidemiological studies.

8.3 Liquid waste

1. Liquid waste from domestic sewage is a valuable commodity that can be used for irrigation, biogas production, fertiliser for field crops and fishponds and may be used for the delivery of biological control agents. However, the health hazards associated with such waste include many communicable diseases and poisoning associated with heavy metals and minerals of industrial origin. Relatively little is known about current use of wastewater in peri-urban agriculture except that it is extensive and unregulated. Little is known about local availability, supply and cost of wastewater or the differences between small and large-scale wastewater reuse projects.
2. A series of publications during the 1980's examined the safe reuse of wastewater and sludge in agriculture and aquaculture. There was considerable progress in the development of systems for safe wastewater production and use which culminated in publication of the WHO (Engleberg) Guidelines (Mara and Cairncross 1989; World Health Organization 1989). The Guidelines relaxed standards for faecal bacteria but introduced new standards for nematode eggs. A number of issues remain unresolved. There is a series of research monographs in tropical public health engineering from the Department of Civil Engineering, University of Leeds, which provide important additional information.

8.3.1 Communicable diseases associated with excreta

The WHO guidelines recognised five categories of excreta related communicable diseases and distinguished them by latency and persistence. Latency refers to the period between excretion and becoming infective to a new host. Persistence is a measure of how long a pathogen remains viable after leaving its host. Together, these help to determine the half-life of pathogens in waste and on crops. Many worms and protozoan parasites have a sufficiently long half-life so that they can contaminate the harvested crop and be transferred through the market chain to the consumer's kitchen. Produce can be decontaminated by peeling, cooking and, to a small extent, by soaking in antiseptic fluids. But further contamination may occur from soil and debris in the kitchen.

8.3.1.1 Non-latent, low persistent

1. This category includes viruses such as infectious hepatitis, protozoa and some helminths. Transmission is associated with personal hygiene and the domestic environment. Flies that breed in organic waste can be important mechanical vectors of some of these diseases and distribute them to the wider community.
2. The WHO guidelines concentrated on standards for bacteria and helminths and not viruses. A recent review of the effect of viruses on human health from wastewater used in agriculture and aquaculture suggests that current bacteriological standards do not provide good indicators of viral content or the efficiency of disinfection procedures and that more research is needed (Schwartzbrod 1995). It also emphasised the need for epidemiological studies to relate clinical ill-health to different levels of viral contamination. Particular concern was expressed about decontamination procedures that use chlorination. The basic requirement for decontamination of wastewater was to reduce the suspended solids by at least 90%. Shellfish were cited as a major transmission route for enteric viruses. The risks associated with sprinkler or spray irrigation were not considered to be a significant source of infection except during epidemics when the viral concentration was very high. It was concluded that wastewater treatment but not disinfection was required and that irrigation of market-garden produce should cease 3 weeks before harvest. Viruses also accumulate in the sludge from waste treatment plants and proper drying and long term storage was required to inactivate them, suggesting greater persistence than previously believed.

8.3.1.2 Non-latent, moderate persistent

This category includes bacteria such as *Shigella*, typhoid and cholera that are viable in untreated wastewater. Transmission by flies may be important. Recent epidemics of cholera associated with wastewater reuse have led to their analysis of sale production systems, see below.

8.3.1.3 Latent, persistent and no intermediate host

- 1 This category includes *Ascaris*, hookworms and *Trichuris*. It is considered the highest risk category in wastewater treatment and reuse because of the long half-life of the pathogens. I-helminthes and cysts are likely to concentrate in sludge. Transmission by flies may be important.
2. The intestinal helminthes such as *Ascaris* are extremely common in many development communities. Transmission occurs through a number of routes, in addition to poorly treated sewage used in agriculture. Hookworms are associated with significant disease. Poorly treated sewage waters can contain viable stages that live in moistened soils. They infect agricultural workers who expose their bare skin to the soil.

8.3.1.4 Latent, persistent and animal intermediate host

This category includes the cow and pig tapeworm and is important where beef cattle are grazed on pasture irrigated with wastewater or pigs scavenge on human waste. There is no equivalent parasite of sheep and goats. The pig tapeworm produces a far more serious disease in people than the cattle tapeworm.

8.3.1.5 Latent, persistent and aquatic intermediate host

This category includes schistosomiasis which has a focal distribution dependent on temperature and the presence of suitable aquatic snails.

8.3.2 Non-communicable diseases associated with hazardous chemicals in drinking water and wastewater

1. Wastewater may contain a number of industrial effluents including cyanides, acids, lyes, mordents, bleaches and heavy metals (arsenic, cadmium, chromium, copper, lead, zinc, mercury). The risk posed by these contaminants will depend on their dilution and uptake pathways. For example, in Damascus chromium salts from leather tanneries are of particular concern. Chromium concentration in surface discharges at the tanneries is about 40mg/i (JICA 1996). Chlorination of effluent containing chromium can produce two toxic products (Tarcher 1992):
 - Carcinogenic and mutagenic products can result from the combination of chlorine with organic materials. This problem seems to be associated with high levels of chlorination in water destined for drinking.
 - Chlorinated chromium salts may change from a less toxic to a more toxic form.
2. Some heavy metals may precipitate in sludge and so concentrations in treated wastewater may be very small. There are suggestions that other mutagenic materials are not removed and may be enhanced by activated sludge treatment (Blevins and Brennan 1990).
3. The risk associated with these chemicals and others depends on the mode of exposure. Wastewater effluent is not usually destined to be drunk. However, the chemicals may percolate to groundwater, accumulate and be extracted for drinking from wells. Some chemicals may accumulate in soils and exposure occurs during consumption of plants grown in those soils. There are soils that are already heavily polluted. For example, some 8% of wastewater irrigated land in China is said to be heavily polluted and some 50% exhibit pollutant accumulation (cited in Chang 1995).
4. Guidelines for limiting human exposure to hazardous chemicals in wastewater used in at agriculture are at an early stage of development (Chang et al. 1995). There are two approaches: prevent any pollutant accumulation in waste-receiving soil-, or, more realistically, take advantage of soil's capacity to assimilate, attenuate and detoxify pollutants. In order to derive acceptable loadings, it is necessary to determine intake through consumption of plants grown in contaminated soils. The tentative conclusions are presented as acceptable concentrations of various organic and inorganic compounds in soil (mg/kg DW). For example: mercury 5, lead 150, chromium 3200. These figures are regarded as first approximations requiring further research.

8.3.2.1 Nitrates and nitrites

1. Drinking water may be contaminated with nitrates and nitrites to an unacceptable level with an associated risk of blue-baby syndrome (methemoglobinemia) The probable threshold for clinical illness is 100mg/L of

NO₃ and consequently the WHO standard for nitrates in drinking water is <50mg/L. The most vulnerable group are infants who are bottle fed or given water to drink (Feachem et al 1983)

2. Six countries of the newly independent states of Eastern Europe report blue-baby syndrome in infants. One third of Lithuania is covered by a drinking water replacement programme for pregnant women. Similar problems are expected to occur in future in other regions and may be exacerbated by wastewater reuse (Environmental Health Project 1995).
3. Nitrate levels in irrigation water are self-limiting (Chang et al. 1995). Excess nitrate has a limiting effect on plant growth and is therefore unacceptable to the farmer. Chang et al refers to the FAO guidelines on irrigation water quality which limits the nitrogen input via irrigation to 5 mg/L, equivalent to 60 kg/ha. In order to avoid leaching to groundwater, they suggest that no more than 5-25 tons of sewage sludge should be applied per ha of cropland. They propose that no numerical limits should be set for nitrate in wastewater because the agricultural limit will suffice.

8.3.3 Assessment of health risks

The WHO Guidelines on the safe reuse of wastewater sets a series of barriers to infection. If a sufficient combination of these barriers are operational then the wastewater should be safe. The barriers consist of treatment methods, irrigation methods, working conditions, types of crop and post-harvest processing.

8.3.4 Vulnerable communities

1. The main vulnerable communities associated with wastewater reuse projects are indicated in Table 27, together with their potential exposure to the five excreta-related communicable disease categories (Mara and Cairncross 1989).

Table 27 Vulnerable communities and excreta related diseases

Communities	Disease				
	1	2	3	4	5
Domestic	x	x			
Sewage plant workers	x	x	x		
Farm workers		x	x		x
Crop handlers		x	x		x
Recreational users		x	x		x
Peripheral communities		x	x		x
Consumers of crops		x	x		
Consumers of cattle and pig meat				x	

The vulnerability of these community groups to the pathogens is determined by a number of factors, including the following.

8.3.4.1 Host immunity

This is only relevant for category 1 and 2 diseases such as hepatitis and typhoid. The immunisation status of workers who handle treated and untreated effluent could be enhanced by a vaccination policy.

8.3.4.2 Host behaviour

1. Community behaviour, or practice, is partly determined by knowledge, attitude and belief. For example, surveys of mothers' knowledge and behaviour to childhood diarrhoea frequently demonstrate that while many mothers know of Oral Rehydration Therapy few practise it. Behaviour such as using protective clothing can help protect workers from exposure to infection, especially to helminths. Agricultural workers exposed to waste water should wear boots. Peripheral communities may stray onto effluent treated land unless deterred by barriers, posters, warnings and health education. Children are of particular concern because they frequently transfer soil to their mouths.
2. When wastewater is used to grow food crops, people may be able to protect themselves by disinfecting vegetable produce in the [tome using boiling water, chlorination, potassium permanganate and other additives. The effectiveness of these procedures is open to doubt.
3. Many people may use rivers, canals and irrigation channels for bathing or fishing. Urban dwellers may visit irrigated peri-urban areas during holidays. Exposure to wastewater or land treated with wastewater may then be common.
4. The vulnerability of consumers to excreta-related communicable diseases depends on what crops they prefer to eat and whether the food is cooked or raw. Preferences for raw salad crops such as tomato, lettuce, parsley, cucumber and mint are particularly important.

8.3.5 Wastewater treatment methods

1. WHO/Engelberg standards for water quality discharged from waste treatment plants and suitable for unrestricted irrigation are:

- viable nematode egg per litre;
- 1000 faecal coliforms per 100ml.

2. These standards should protect agricultural workers, neighbouring communities, consumers of salad vegetables as well as bathers and users of public parks. These standards are equivalent to removing 6 orders of magnitude of bacteria (99.9999%) and about 3 orders of magnitude of helminths (99.9%). The standard can be obtained from a simple plant containing 4-6 waste stabilisation ponds with an overall retention time of >20 days at 20°C.
3. The WHO Guidelines were based on best available data but were not fully confirmed by epidemiological studies (U Blumenthal, *pers. comm.*). Epidemiological studies since 1989 have tested those standards and concluded that they are about right for protecting consumers (Blumenthal et al. 1991/2; Cifuentes et al. 1991/2). However, the nematode egg guidelines may need to be made twice as strict when wastewater treatment systems are unstable, when secondary contamination with untreated wastewater can occur or where wild vegetables are harvested and consumed by field workers (Blumenthal et al. 1996). Further epidemiological investigations are underway to establish the relative risk of different levels of water quality where water is used for salad crops (S Cairncross and U Blumenthal, *pers. comm.*). NR managers are advised to measure the relative risk in their own peri-urban vegetable growing projects.
4. There is a debate about the relative merits of activated sludge treatment plants (ASP) versus waste stabilisation ponds (WSP) in relation to the WHO Guidelines. An ASP is far more expensive to construct and operate than a WSP but requires less land. Land is expensive in peri-urban areas. A WSP retains the agricultural nutrients in irrigation water. However, in closed aquifers this may pose a danger of nitrate and potassium contamination of groundwater. The World Bank noted that an ASP costs >5.8 times more to construct and >1.5 times more to operate than a WSP (Shoval 1990). It concluded that WSP were cheaper than ASP even when land prices were very high. Waste could be pumped far from a city to areas where land was cheaper. There are concerns about the high evaporative losses from WTP in areas of water scarcity, but these should be offset against the high operational requirements of ASP.
5. According to the WHO Guidelines, activated sludge plus secondary sedimentation can achieve a reduction in bacteria of 10^6 and chlorination a reduction of $10^{2.6}$. Activated sludge can achieve a reduction in helminths of $10^{0.2}$ and chlorination a reduction of $10^{0.1}$. The larger removal rates depend on retention times >24 hours and efficient operation. In practice, the optima may not be achieved. For example, in Egypt an activated sludge treatment plant with chlorination reduced faecal coliforms and other bacteria by 10^4 and all helminths except hookworm (Wahaab, 1990). Protozoa were not removed. Salmonellae and cholera vibrios were removed completely. Viral density was only reduced by 33%. In Jordan, a WSP outside Amman does not operate as designed because the current level of wastewater production far exceeds its capacity.
6. An ASP produces large quantities of dried sludge which is in high demand as a soil conditioner. The treatment process concentrates some helminths and other pathogens in the sludge. The WHO standard for surface application of sludge derived fertiliser is <1 viable nematode egg/100 g or kilogram wet-weight and <1000 faecal coliforms/100 ml or 100 g wet-weight. In order to meet the ITTO standard, sludge needs to be treated at temperatures >50°C for 14 days, composted, applied sub-surface or stored for periods of about one year. Sludge treated at lower temperatures and stored for shorter periods is still a significant health risk.
7. A practical guide to the laboratory measurement of faecal coliforms and nematode eggs in wastewater has been published very recently (Ayres and Mara 1996). It lists the advantages and disadvantages of various methods and indicates where further research is needed. Measurements should be made 1-4 times per month, depending on the treatment process used.
8. There is a need for more methods of treating liquid waste including on farm stabilisation ponds, reed beds, duck weed farming and artificial wetlands and the research in these areas needs following up. Research in progress includes experiments with covered waste stabilisation ponds for farm use (T Brabbin *pers. cumin.*). The intention is to raise the water temperature sufficiently to kill nematode eggs.
9. A website contains a thought provoking article on natural systems for the treatment of wastewater (Montgomery 1997). Systems covered include ponds, constructed wetlands (CWL), hyacinth ponds and reed beds. The merits and demerits of each are listed. Good removal rates for pathogens, heavy metals,

Nitrates and other pollutants are reported in many of these systems. The need for mosquito control is briefly discussed but the solutions presented are open to doubt.

8.3.6 Type of crop

1. When effluent is used for irrigation choice of crop can provide an important barrier to the transmission of pathogens (Mara and Cairncross 1989). However, over stringent crop restriction reduces the economic benefit of the irrigation. The WHO Guidelines divide crops into three categories and recommend safety requirements for each.

8.3.6.1 Category A: Protection only for field workers

This category includes dry fodder, fibre, wood and seed crops. As the crops are processed before consumption there is negligible risk to the consumer. However, field workers are exposed to the effluent and require protection by rubber boots, potable water supplies and hygienic behaviour.

8.3.6.2 Category B: Further control measures may be needed to prevent transmission

This category is affected by type of irrigation and the category assumes no spraying. It consists of orchard, vineyard and vegetables to be cooked or processed. Irrigation should be stopped a week or two before harvest and the crop should not contact the ground. Spray irrigation would contaminate the fruit.

8.3.6.3 Category C: Treatment to Engelberg standards essential

This category consists of crops that are normally eaten raw. It also includes public parks where people can sit and play on irrigated land. Wastewater treated to the Engelberg standards promoted by WHO is regarded as reasonably safe for unrestricted irrigation.

8.3.7 Irrigation method

1. The WHO Guidelines list five application categories: field flooding, ridge and furrow, sprinklers, drip feed, and sub-surface. Each requires different levels of protection of field workers, crop handlers and peripheral communities.
2. In many countries there is a strong interest in making irrigation more efficient by moving from field flooding to drip feed and spray. Drip-feed or localised irrigation methods increase human safety and are highly recommended. Spray irrigation with treated effluent is only practical on large farms where sanitary barriers can be constructed at the periphery.

8.3.8 Post-harvest processing

For many practical reasons it is likely that salad crops will continue to be grown in contaminated waters. Attention must then turn to methods of ensuring their safety at the post-harvest stage. There are two main options:

- decontamination;
- crop restriction and certification.

8.3.8.1 Decontamination

The common practice of domestic disinfection of salads is of dubious value and there may be an opportunity for mass disinfection of market produce, as is the practice for water cress in the UK (*pers. comm.* E Potts). *See also food safety*

8.3.8.2 Crop restriction and certification

1. The WHO Guidelines on wastewater reuse develop standards for water treatment and have a different perspective to that of the user in the agricultural community. The perspective of the tiler is presented in two FAO papers (Pescod 1992; Westcot unpubl). Westcot's paper builds on the previous work done by WHO but starts with the premise that appropriate treatment plants will not be widely installed for a long time to come. The main action required is crop restriction or sale production areas for high risk crops. But this action must be based on well-defined water quality standards. The report grew out of a project in Chile that sought methods to restrict and certify the safety of vegetables in the wake of a cholera epidemic. In Metropolitan Santiago some 60% of the irrigated area used water with >10,000 faecal coliforms/100ml. A vigorous program of crop restriction reduced the number of cases of cholera, hepatitis and typhoid. Opponents of this programme note that it substantially increased crop prices and denied the benefits of fresh vegetables to low-income communities (Sinit et al. 1996).
2. The alternative to controlling quality at the point of treatment is to control the place where the water can be used. This requires a broader institutional structure and jurisdiction over cropping in the reuse area. Since such jurisdiction is usually poor and illegal extraction of water frequently occurs, an alternative is to

Identity safe production areas and use market pressures to promote safe crop production. The report describes an approach that issues water quality certificates to producers.

3. The paper will be of general interest of NR managers using wastewater because it also provides a review of wastewater borne pathogens, including survival times in sewage and soil.
4. The basis for water quality was that used in the WHO guidelines, while emphasising that those standards were for the design of treatment plants and not for water quality at the point of use. The proposed system of water quality monitoring uses faecal coliforms rather than on helminth eggs. Techniques for monitoring helminth eggs were not considered to be well established. The emphasis of the report is extraction [torn contaminated rivers. Some 45% of 110 rivers tested throughout the world carried faecal coliform loads higher than recommended by WHO for unrestricted irrigation. In addition, 15% carried faecal coliforms levels that were 10 times in excess of the standard of 1000/100m³. The report suggests that the effect of rivers on the longevity of helminth eggs is unknown and requires further research. The association between coliform and helminth levels in rivers is also unknown. Reliable routine methods of counting low densities of helminth eggs in wastewater are urgently needed and research of this nature should be promoted. But see Ayres (1996). The report reviews several available methods of monitoring faecal coliforms and the need for portable sampling systems. It recommends further research on the practical field use of membrane filter techniques. It provides a decision tree for the analysis of faecal coliform counts that could provide a legal basis for a crop control programme. The need to separate coliforms of human and animal origin is explained.
5. The report notes that crop restriction and certification programmes can offer protection to the consumer but not to the producer, labourer or peripheral community. These groups will still have contact with contaminated and potentially infectious water. The difficulties associated with crop restriction are discussed. Priority is given to establishing national programmes to identify large irrigated areas that can safely meet national and export vegetable production goals without the cost of implementing large surveillance and enforcement programmes for crop restriction. Such programmes should be a joint activity between Ministry of Health and Ministry of Agriculture and should:
 - assess the extent of contamination of existing irrigation waters;
 - define an approach for certifying safe production areas;
 - maintain a database that will support national strategy development.
6. The report discusses what is needed to assess the extent of irrigation water contamination. This includes a GIS that identifies rivers, discharge points, monitoring points, major vegetable growing areas and the percentage of each vegetable species grown in each area. It emphasises that monitoring points should be at field level.

The basis of the proposed certification programme is to create positive market pressures for certified crops and negative market pressures for unsafe crops. These economic pressures must operate in peri-urban areas where high risk, high economic return crops are grown. In Chile, there was a heightened awareness of product quality by consumers in the wake of the cholera epidemic. This led farmers to adopt an informal system of labelling their produce declaring that it was grown in safe water. This, in turn, focused consumer interest. The report discusses various requirements of a certification programme. One issue is that producers who submit the crops for laboratory testing place themselves at considerable economic risk. The report therefore proposes that instead of certifying the quality of each product, there should be a more general certificate that the product was produced in a safe environment. This should include certification of the water used for production, processing and packing.

9. Cross cutting issues

9.1 Summary

Table 28 Summary of health linkages for cross-cutting issues

Development Sub-category	Communicable diseases	Non-communicable diseases	Malnutrition	Injury
Food safety	Food storage, contamination	Food adulteration, contamination, plant poisons, antibiotic residues	Consequence of aflatoxins	
Labour mobility	Promiscuity, crowding, poor sanitation	Dust	Rural deprivation	
Changes in land use	Vector breeding sites, water pollution, dust	Dust	Loss of natural resources, land and subsistence	Traffic, occupation
Construction	Promiscuity, poor sanitation, vector exposure			Occupational exposure
Water supplies and pollution	Water quality			
Tourism and recreation	Water quality, exposure to sewage			

- Food crops may be contaminated by chemical uptake from air, water or soil media that affect consumers.
- Foods are often freshly contaminated during post-harvest processing, marketing and cooking as both domestic and street food.
- Foods are often contaminated during storage, for example by moulds and bacteria.
- Migrant labour is especially vulnerable to sexually transmitted diseases, including HIV.
- Returning labourers carry communicable and non-communicable diseases back to their family homes.
- Loss of rural labour to migration may interfere with subsistence crop production.
- Changes in land use in the peri-urban environment may increase or decrease vector-borne disease transmission. It may also increase malnutrition by removing wild food sources or by loss of subsistence crops.
- Increased road traffic and conflicts between motorised and non-motorised transport leads to increased traffic injuries.
- Construction workers are vulnerable to sexually transmitted diseases as well as a range of occupational diseases.
- The conflict between drinking and irrigation water supplies may lead to rapid falls in groundwater levels and pollution of drinking water with pathogens and minerals. It may also deprive peri-urban - communities of their water sources.
- Attitudes and practices of rural and peri-urban people towards water and health issues may be dissimilar.
- Liquid waste discharges from cities pollute bathing waters in peri-urban areas. Recreational users may be ill-informed about the associated risks.

9.2 Introduction

1. There are several issues that occur as a component of so many different development activities that they require separate attention. Of particular concern are projects which cause or contribute to population growth and population movement. Development projects may change fertility and hence the size of the vulnerable population of pregnant women and infants. The relationship is complex and outside the scope of this review.
- 2 Disruption of the social environment provides a high **risk** situation for transmission of diseases such as HIV. Individuals may experience feelings of powerlessness, and lack of control over their lives, separation from partners, reduced social concern about casual sexual relationships, worry about immediate provision of food, use of alcohol and other addictive drugs as well as a lack of information and resources. This may be exacerbated by homelessness, landlessness, unemployment, rapid peri-urban settlement, migration, population relocation and poverty (Zwi 1991).

9.3 Food safety

1. Much natural resource development is concerned with food production and delivery and there are many associated health hazards. Some 1 500 million children under the age of five suffer from diarrhoea and 4-5 million die per year. Many diarrhoeal episodes may be due to foodborne rather than waterborne pathogens (World Health Organization Commission on Health and Environment 1992b). Some of these foodborne pathogens, such as *Listeria* and *Toxoplasma* are dangerous during pregnancy as infection of the foetus can cause death or serious malformations.
2. Many urban dwellers cannot find formal employment and have adopted a wide range of livelihood strategies that affect household activities and health. They often become vendors of street foods. This provides a cheap source of food for the poor urban population as well as a source of income for the vendors, who are often disadvantaged women. Studies of street foods in Africa suggest that street food was no less nutritious than modern commercial food and was no less safe than other foods available in the household, providing it was eaten soon after purchase. The purchasers made savings in preparation time, fuel costs and costs of the foodstuffs (Atkinson and Merkle 1993).

9.3.1 Hazard analysis critical point control (HACCP)

1. Hazard analysis critical point control (HACCP) is a widely used procedure in food safety studies. It consists of determination of microbiological hazards; assessment of associated risks; risk management through critical point control; and monitoring of critical points (Bryan 1992; Bryan 1993, Natural Resources Institute, undated #601). It is similar to the more general health impact assessment procedure advocated in this review. Some key informants suggested (*pers. comm.*) that adoption of HACCP enables governments to reduce the number of food inspectors that they employ.
2. NRI has an active programme of research on food quality which includes food safety and human health. The programme uses HACCP methods to define indicators of food quality. These indicators may be useful for illuminating a "food quality transition" associated with the rural to urban transition. Further research may be needed to determine the epidemiological consequences of food quality risk factors in new environments. For example, key informants suggested that traces of aflatoxin in weaning foods may be more significant when weaning occurs early as a consequence of urbanisation.

Box 12 Example of use of hazard analysis critical point control

A number of studies have used HACCP to analyse the hazards associated with food preparation and storage in poor domestic environments and some of these are specifically peri-urban. Bryan et al (1988) studied domestic food preparation by peri-urban migrants in Lima, Peru. The micro-organisms of interest were *Salmotella*, *Shigella*, *Staphylococcus*, *Clostridium*, *Bacillus cereus*, *Listeria coli* and general aerobic mesophilic bacteria. The households studied were of diverse rural origin but their food preparation behaviours were similar. Food was prepared in the morning, eaten at lunch and held without heat until supper when it was reheated. Critical control points were identified as food preparation, cooking, storing and reheating. Particular concern was expressed about the holding period which would enable micro-organisms to germinate and multiply. Infants in the households had diarrhoea and contamination of food by faecal matter was observed. Thermos and containers for *babies* milk were not properly sterilised and baby foods were kept too long after opening or preparation. Domestic animals including chickens, pigs, cats and dogs had access to food preparation areas. Reheating procedures were relatively ineffective. Use of refrigerators was poor or they were unavailable. In addition to the domestic food preparation, there was a mother's club where nutritious food was prepared and sold. Local inhabitants purchased this food at about noon, took it home and stored it until the evening meal.

The study listed the opportunities available for changing risk behaviour at the critical control

9.3.2 Codex Alimentarius Commission

1. The Codex Alimentarius Commission was established in 1961 under the Joint FAO/WHO Food Standards Programme (Food and Agriculture Organization and World Health Organization 1990). It provides a uniform global system for protecting the health of consumers and ensuring fair practices in food trade by establishing standards. Committees of particular interest include:
 - residues of veterinary drugs in food-
 - food additives and contaminants;
 - pesticide residues.

2. All countries in the UN system are members but it has been noted that very few African countries actively attend meetings (various informants) One reason for this may be the low volume of food exports from the region. The main focus of this programme seems to be international trade and it is normative rather than research oriented. Rapid urbanisation problems have been reviewed by the commission (Lupien 1985).

9.3.3 Stored produce

The international trade in food products depends on an increasingly complex technology. Many countries lack the necessary regulations and enforcement to ensure product integrity. Refrigerated products are especially important in terms of food safety (World Health Organization Commission on Health and Environment 1992a).

9.3.3.1 Communicable disease

1. Listeriosis, caused by the bacteria *Listeria monocytogenes*, is one of many food borne pathogens which is of great concern to the commercial food industry. The bacteria can be found in a variety of dairy products, leafy vegetables, fish and meat products. It can grow in refrigerated foods and is heat resistant. Those predisposed to listeriosis include the immuno-compromised, pregnant women and their foetuses. Meningitis, spontaneous abortion and septicaemia are the primary manifestations of the disease (Farber and Losos 1988). The introduction of a refrigerated food industry could result in an increase in the incidence of listeriosis. An outbreak of listeriosis in California was linked to the consumption of Mexican-style soft cheese and involved more than 300 cases, 30% of which were fatal (Farber and Losos 1988).
2. A study in Liberia observed higher rates of *Campylobacter* in urban versus rural children. The water quality was better in urban areas. Food was prepared in bulk and stored for several days. The two main reasons for long food storage times were the employment of women outside the home, which reduced time available for cooking, and the high price of charcoal in urban areas (Atkinson and Merkle 1993; World Resources Institute 1996).

9.3.3.2 Non-communicable disease

1. Stored food products are susceptible to contamination by mycotoxins, such as aflatoxin. These are produced by fungi at specific conditions of temperature and humidity (World Health Organization 1979a). Storage of produce in plastic bags is especially dangerous. The many adverse effects can include reduced effectiveness of immunisation programmes and increased susceptibility to communicable diseases such as measles and HIV. Animal experiments provide evidence of interactions between malaria and aflatoxins (Hendrickse et al. 1986; Young et al. 1988).
2. The adverse effects of contamination by mycotoxins can include acute fatal poisoning, immuno suppression and long term risks of liver cancer (Hendrickse 1991). The toxin is an extremely stable molecule that is unaffected by cooking, fermenting or pickling. There is no reliable method of decontamination. The fungi can infect growing crops as a consequence of pest damage and produce toxins before, during or after harvest. Outbreaks of aflatoxicosis are common in farm animals and the toxins can carry over to meat and milk. Aflatoxins cross the placenta and are excreted in mother's milk (Maxwell et al. 1989). Powdered milks may also contain aflatoxins. Occupational exposure occurs in workers of stored products. An outbreak of acute fatal liver disease in India was associated with ingestion of heavily aflatoxin-contaminated maize. Geographical variation in liver cancer prevalence has been associated with daily aflatoxin intake (Tendrickse 1991).
3. The export of stored food products by developing countries to industrialised countries is jeopardised by mycotoxins. Products are tested on arrival and may be condemned. Turkish fig exports to the EC were affected in 1989. There are reports of condemned foodstuffs being resold to poorer countries. Emergency food relief supplies can also become contaminated while awaiting trans-shipment. (See also Jemmali 1995).
4. Aflatoxins from mouldy feed are expressed, but not concentrated, in cows' milk. The milk is often fed to infants that are weaned earlier than usual due to the pressures of the urban economy. There is still uncertainty about the maximum acceptable level of aflatoxin contamination in various foods but agreement that there is a substantial long-term risk of liver cancer associated with its consumption.
5. Street sellers may obtain their raw materials from a range of uncontrolled sources and these may often be low grade or contaminated. An anecdote (FAO, *pers. comm.*) illustrates this point. The aflatoxin level of samples of street purchased peanut butter was found to be remarkably high. This was traced back to the producer who obtained raw materials from a dump used by the official peanut marketing sector for the disposal of poor quality produce. There was an interesting link here with the lack of proper waste disposal facilities.

9.3.3.3 Malnutrition

- 1 Aflatoxin exposure is suspected is suspected to be a common cause of kwashiorkor, in association with protein-energy malnutrition (Hendrickse and Maxwell 1989)

9.3.4 Other food safety issues

- 1 . There are many food safety issues associated with livestock and fish production. *See also aquaculture p52, livestock, p57, and water and food-borne parasitic diseases, p21*
2. Recent examples of emergent food borne diseases include *Usclierichiei soli* 0157117 (EHEC) and multiple drug resistant *Salmonella typhimurium* DT 104 (M.DRST) (World Health Organization 1996a, World Health Organization 1997b). Both appear to be transmitted to people by consumption of undercooked meat and milk products. They are new strains of old and well-known organisms that are more toxic. They usually cause diarrhoea. However, in patients who are immunocompromised, very young or very old a serious systemic infection can develop which is life-threatening. MDRST is believed to have emerged from antibiotic treated domestic animals. Prevention measures include improved hygiene when handling animals and animal products, and adequate cooking and storage of products.
3. The spread of multi-antibiotic resistant strains of pathogenic organisms from antibiotic treated animals remains a potentially important human health issue. Use of contaminated animal faeces may spread drug-resistant pathogens through the food chain. Poultry are of particular concern because they are commonly reared intensively in the peri-urban environment and their faeces are then used in other parts of the farming system. Widespread use of antibiotics in aquaculture may also lead to antibiotic resistance in human pathogens although there are no studies confirming this. *See antibiotic resistance, p51.*
4. There is widespread agreement that insufficient is known about post-harvest decontamination of vegetable crops grown with solid or liquid waste. WHO have commissioned a review of the subject and an outline is provided by Dr Alan Reilly. The title is "Development of WHO Guidelines for the decontamination of fresh fruits and vegetables eaten raw". The report will review the scope of the problem, the epidemiological aspects, known actions that can be taken and their efficacy and will recommend future research. The practice of decontaminating salads in the home with potassium permanganate or chlorine is considered of low efficacy. However, one key informant suggested that if strong solutions are used they taint the salad and the substantial washing that then takes place to remove the taint would wash off many micro-organisms, especially nematode eggs.
5. At the commercial level, there is special concern about the international trade in fruit and salad crops. Where these are kept moist and refrigerated there is concern that pathogenic micro-organisms can survive as long as the product itself. There was anecdotal evidence, for example, of cases of shigellosis from imported lettuce and hepatitis from imported strawberries.
6. Processes that work in rural areas may not work *in* the peri-urban environment. An example cited by a key informant concerned cassava processing to remove cyanide. When this is scaled up by cottage industries a large amount of cyanide is discharged into the peri-urban environment. There is said to be a widespread preference for fermented starches both for the taste and for the improved food safety. An informant at FAO suggested that the resources spent to develop low cyanide cassava had been wasted because most consumers wished to ferment it anyway and this process removed the cyanide. However, it was also suggested that commercialisation led to reduced boiling of crops before fermentation and that this could increase exposure to aflatoxin
7. Key informants at FAO suggested that chemical contamination of foods was reasonably controlled in developed countries but rife in sonic developing countries. (See also United Nations Environment Programme 1992. Natural Resources institute undated).

9.4 Labour mobility and resettlement

- 1 . Mobile populations are vulnerable to new health hazards (Prothero and Gould 1984). Many different kinds of population movement may occur in response to a development project.
2. Economic development of plantations, mines and other industries has usually been accompanied by labour mobility. Temporary workers, drawn from a largely underdeveloped hinterland, are exposed to severe health hazards. These hazards are generally occupational, such as the exposure to dusts and toxic chemicals, or associated with poor living conditions. Tuberculosis, pneumoconiosis and pneumonia are common (Giel and Van Lwijk 1967). Migrant workers are also vulnerable to mental disorders (International Labour Office 1974; Levi 1984; International Labour Office 1986).

3. Increasingly, women are forming part of the migrating work force as rural demand for their labour decreases. They migrate to new industrial developments in the cities or to concentrations of male labour. Female headed households are more likely to live in poverty, in substandard housing with unsafe drinking water and inadequate sewers and with insufficient income to eat a balanced diet (Browner 1989).
4. Migrant labourers may choose to remain when a construction project is completed. They may create new settlements without infrastructure, live in unsanitary conditions and contribute to disputes over land and common property resources (Odingo 1979).
5. Two important forms of resettlement are: settlement of new lands to achieve a public good and displacement to resettlement as part of the attainment of a public good. In the former case the settled community represents a productive resource and will receive support. In the latter case the community are viewed as an obstacle to development that may receive either negligible or inappropriate support (Colson 1971; Roundy 1989). Health hazards are rarely seen as a major constraint to resettlement success compared with problems of administration or agricultural planning. 56,000 Tonga people were displaced to resettlement by the Kariba Dam. A subsequent study noted that: disruption of social routines lasted more than five years; the community became hostile to government; local leaders lost their legitimacy; and the community were less willing to accept innovations in health care (Colson 1971). Resettled rural people frequently take their compensation money and migrate to urban slums where they are disoriented, unsupported, poor and susceptible to alcoholism and prostitution (Bhatia 1991).

9.4.1 Communicable disease

1. Migrant labour systems world-wide present high risk situations for communicable disease transmission, such as HIV (Zwi 1991). Many labourers are single males who are separated from their families and communities. Workers' accommodation is often intolerable, insecure and depressing (Hunt 1989). High prices, legislation and poor quality of urban dwellings forces migrant workers to live apart from their families. The men seek companionship with women living near their place of work, posing a high risk for multi-partner sexual activity and the spread of sexually transmitted diseases including HIV infection. One major cause of heterosexual spread of HIV in Africa has been ascribed to the special prominence of labour mobility in that region (Hunt 1989). The prevalence of STDs often increases during the harvesting season, emphasising the link the labour mobility (Bennett 1964). Other observations studies from Nairobi, where 94% of those infected with STDs were working more than 400 km from their native area (Verhagen and Gemert 1972), and studies from Kampala, where half of STD patients came from the surrounding rural area and half were migrants (Bennett 1962).
2. Wage employment for women is often harder to obtain or poorer paid than for men (Browner 1989). Women in such a position are at risk from sexual harassment and rape and some, perhaps many, become sex workers. Others may be required to exchange sexual favours for food and accommodation. Boys and young men may do the same. There is evidence that heterosexual STD transmission was restricted in South African ► nine workers by homosexual practices (Moodie 1989). Impoverishment, rapid urbanisation, anonymity of city life, migrant labour. poor wages and dependency of women were identified as the main factors leading to women seeking sex in exchange for money in Bulawayo, Zimbabwe (Wilson et al. 1990).
3. Returning labourers may carry new communicable diseases to their place of origin, where health care facilities are frequently poor (Packard 1989). These include STDs that lead to female infertility (Raikes 1989). Migrant workers and militia may have been the means by which a cholera epidemic moved from Tanzania to most of Southern Africa between 1978 to 1983 (Meakins 1981). A study showed that 60% of miners diagnosed as having tuberculosis while working in South Africa died within 2 years of returning home (Packard 1989).

9.4.2 Non-communicable disease

1. Returning labourers may have occupational diseases for which industry has failed to accept responsibility. The burden for their care falls on their families. Some conditions, such as asbestosis, or malignant mesothelioma, a cancer of the lining- of the lung due to asbestos exposure, may be especially disabling.

9.4.3 Malnutrition

1. The hinterland itself may be a dependent labour reserve with declining agriculture, labour shortage, poor health care facilities and malnutrition. The burden of both agricultural production and care of dependants falls more heavily on the women who are left behind. Crop production may then shift to more easily grown but less nutritious staples; child care may also decline. Malnutrition and disease susceptibility may increase in consequence. The *family* may not be able to leave the impoverished land without losing their claim to it (Raikes 1989). On the other hand, remittances from migrants may raise household incomes and provide access to a wider range of food. A study of a rural labour reserve in Zambia during the 1930's concluded

that labour shortage prevented bush clearing, leading to overuse of cultivated areas and a shift to less nutritious crops such as cassava (Richards 1939).

9.5 Changes in Land Use

Changes in land use can effect both the environment and human contact with the environment. Land use in pen-urban areas may change from agricultural production to infrastructure development or industrial processes as well as from one agricultural system to another. Previously unexploited land may have provided natural regulation systems such as flood protection or habitats for predators of agricultural pests and valuable resources for the local population.

9.5.1 Communicable disease

1. The abundance of vector breeding sites and the degree of contact between people and vectors may be altered. The abundance of animal host reservoirs of pathogens may also change.
2. Land distribution schemes may promote colonisation of new lands. Settlers are likely to encounter natural foci of communicable diseases for which they may be ill-prepared. Examples include encounters with leishmaniasis in the steppes of the former USSR and in the forests of South America (World Health Organization Commission on Health and Environment 1992a). In forest areas, the opening of new roads has encouraged an influx of farmers, miners, loggers and others. In Brazil there has been a serious resurgence of malaria concentrated on settlements, mines and peri-urban areas (Coimbra 1988).
3. Deforestation tends to degrade watersheds, leading to increased surface run-off Erratic stream flows lead to alternate water shortage and flooding. Floods contaminate potable water supplies. Water shortages lead to reliance on contaminated supplies. Both promote waterborne disease transmission.
4. Changes in land use due to change in agricultural practices, use for mining, construction, reservoirs or road building can remove surface cover and degrade soils. Exposed, dry soils turn into dust bowls. High levels of air-borne dust promote eye and respiratory disease and increased transmission of meningitis (Greenwood et al. 1984).

9.5.2 Malnutrition

1. Many development projects reduce the land available for the gathering of common property resources such as food, water or fuel. Common property resources and forests play a critical role in cushioning the effect of seasonality and food shortage. This role is especially important for the more vulnerable members of communities and households whose entitlements are few. Policies which protect common land strengthen the coping mechanisms of the poor (Agarwal 1990). The very poor, and among them pregnant and lactating women and pre-school children, are especially vulnerable to infectious diseases as a result of body weight changes associated with seasonal malnutrition and immuno-depression (Carswell et al. 1981).
2. Loss of natural resources or changes in farming systems may increase the workload of women who are already overworked. The excess work may lead to a negative energy balance and a reduction in their nutritional status. Another consequence is that women may have less time available to care for children or attend at health clinics. The increase in workload can occur in several ways. It is often the duty of women to gather wild food, fuelwood or to collect water. When such land is used for a development project, the community may be deprived of a vital resource. Alternative supplies of that resource may be further away and the workload of women is increased.
3. Switching land use from subsistence to cash crops can also increase women's workloads. Cash crops may require more work in areas for which women are traditionally responsible, such as weeding. A change of cropping system may alter the flow of cash into the household. The cash earned may be controlled by men and not used to buy additional food for the family as women would prefer, This may replace a subsistence system in which food is grown and used directly for household consumption. The consequence may be a reduction in family nutrition.
4. Land tenure, legal access and control over land can have important effects on household income and hence health. Other determinants of household income include improved access to credit, working capital and physical security. Development schemes have sometimes ignored or suppressed women's land rights, negotiations about land reallocation being conducted with men. in Africa, particularly, loss of land customarily used for subsistence crops has been associated with food scarcity (Rogers 1981). A (wide range of development projects increase the value of farming land, promoting land sales and cash cropping and reducing food security.

9.5.3 Injury

Change in land use may bring an increase in traffic, an increase in contact between people and roads and an associated increase in road traffic injuries. Dwellings or business operations may be established by individuals without any consultation with the authorities. Even planned developments by government departments or development agencies may not go through a consultation process with other departments. Often the relevant technical and planning expertise may be in short supply. Responsibilities in such areas may overlap or be duplicated or there may be no organisation at all responsible. Access ways, buildings and advertising hoardings may then be built too close to the roadway. This creates conflict between pedestrians and traffic. It also creates conflict between stationary, slow moving and fast moving traffic (See also Ross Silcock Partnership and Overseas Unit of the Transport and Road Research Laboratory 1991).

9.6 Construction

Many development projects include a construction phase. Large scale construction requires migrant labour. Small scale construction may use a local labour force, sub-contracted through the informal sector. Special health services are often provided by construction companies for large projects. Such facilities may or may not be made available to other vulnerable communities, such as resettlers and temporary informal sector residents. The facilities may or may not be integrated into the national health system when the construction phase is completed.

9.6.1 Communicable disease

1. Construction workers are subject to a range of communicable diseases as a result of migration from different environments. Construction camps are notoriously insanitary. The large concentration of single men and a population of camp followers provides a situation of high risk of STD transmission. Malaria transmission has frequently been affected by construction (Rao et al. 1916; Brown and Deom 1973; Tauli 1986).

9.6.2 Non-communicable disease and injury

1. Occupational health and safety are key issues in construction projects. Workloads are heavy and there is often exposure to unsafe noise levels, dust, toxic chemicals, gases, vibration, flammable materials and high temperatures. Much morbidity is work-related rather than occupational: associated with stress, long hours, low pay, poor food, smoking and drinking. In the UK construction industry there are 10 fatalities per 100,000 employees per year. The ratio of major injuries to fatal injuries is 27. Cancers, respiratory and circulatory diseases are more common than in other workers (Snashall 1990). Many women are involved in construction work and the work conditions may increase their vulnerability to spontaneous miscarriage. High mortality rates from injuries and infection have been noted in children living on construction sites (Bhatt et al. 1988).
2. The use of major items of equipment such as turbines, bulldozers and the lorries required to move large amounts of soil and concrete provides major hazards for road users (Webster 1960). In the construction of the Kainji dam in Nigeria, road crashes and collisions were the most important cause of death and of major morbidity. Such incidents caused more deaths than all the many communicable disease hazards of the areas (Wyatt 1991).

9.6.3 Malnutrition

1. The nutritional status of poor labourers together with anaemia associated with a parasitic burden, significantly reduce productivity (Brooks et al. 1979; Wolgemuth et al, 1982). The energy expenditure of heavy labour may exceed energy intake. A study of road workers in Kenya found helminth infection and anaemia were common and 67% were malnourished. "The effect of energy food and iron supplementation improved productivity. But many workers used it as a partial substitute for their normal diet. Surprisingly, the nutritional status of women was better than that of the men (Wolgemuth et al 1982)

9.7 Water supplies and pollution

See also pollution of water by agriculture, p48

1. In areas of water shortage there is frequently a conflict between water abstraction for drinking versus agricultural and industrial uses, especially in peri-urban areas (Listorti 1996b). In the absence of effective planning, the most economically powerful abstractors are likely to dominate the process. This may be manifest in rapid and unsustainable falls in groundwater levels, as is occurring in Sana'a, Yemen for example. Where effective planning prevails, drinking water supplies are likely to receive priority - providing decreased resources for agricultural development.

2. At the same time there may be little control of pollution of the groundwater resource. The peri-urban poor faced simultaneously with the need to increase the depth of boreholes in order to abstract water of decreasing quality. Potential pollutants include pathogens, heavy metals, nitrates and salts. Pathogen contamination is likely to occur mainly from poorly sealed boreholes as pathogens do not usually move far through the soil. The other contaminants do move through soils although heavy metals may become bound to soil particles. Saline intrusion is a consequence of excessive freshwater abstraction, particularly in coastal areas.
3. WaterAid, an NGO, have published a stimulating review of water shortage and waste disposal problems (Black 1994). The report is principally concerned about the 18 developing country cities predicted to have over 10 million inhabitants by 2000. Many of these cities face an absolute shortage of drinking water due to aquifer depletion or pollution of surface supplies. The report cites a World Bank review that concludes that every time a new engineering scheme replenishes an urban water supply from further away the unit cost of raw water doubles. The report argues that there has been a consistent research bias towards the rural poor and the urban rich and that the urban (and implicitly peri-urban) poor have been neglected. It suggests that despite widespread agreement to low-cost, people-centred approaches, some 80% of investment was still on high-cost technologies. Less than 5% of donor aid was spent on low-cost solutions. Attitudes and practices observed in the rural poor towards health issues have been attributed inappropriately to the urban poor. The report argues that public supply of infrastructure and the removal of responsible action from individuals cannot solve the current crisis. The solution involves a reappraisal of the slum dwellers as upwardly mobile entrepreneurs. The report suggests that residents of overcrowded, flood-prone warrens place a high priority on sanitation compared with the rural poor. Consequently, they are prepared to pay for services. A number of NGO projects are cited in support of this suggestion. The report concludes by advocating a new sanitary revolution - different in concept to the one employed in 19th century Europe.

Box 13 Strategic sanitation plan, Kumasi

Kumasi is the second largest city in Ghana with a population of about 1 million (Gear et al. 1996). Three major sanitation plans have been prepared over the past 40 years, all based on expensive conventional mains sewerage. In 1996 there was still no mains sewerage city wide and conditions had deteriorated. About a quarter of the population relied on "pan latrines" (buckets). The municipality was short of money and had laid off 400 night-soil collectors. Nightsoil was being emptied into streams and drains, septic tanks were overflowing. Less than 10% of the solid waste was properly collected although over \$1 million revenue was being collected for this purpose. Public latrines were not being maintained. A strategic sanitation plan was prepared with World Bank support. The new plan recognised the need to provide sanitation to all and not just the privileged few, to consider various different sanitation technologies, taking account of user preferences and willingness to pay. In low density indigenous housing areas, where 60% of the community lived, ventilated improved pit latrines were chosen. The design was altered to accommodate the number of people using each latrine and a cost sharing system was worked out. The demand for public latrines was carefully calculated. Many components of the plan were implemented by the private sector including construction, operation and maintenance. Major lessons learned were that people were willing to pay, the private sector participation was effective and that technical solutions do exist.

9.7.1 Groundwater

1. An overview of groundwater contamination issues in relation to impact assessment is provided by Canter (1996). Although focused on US conditions, this book contains many insights into the nature of groundwater, soil and pollutant interactions. It provides a comprehensive typography of sources of contamination and an extensive bibliography.

9.8 Tourism and recreation

1. Much domestic and industrial liquid waste is discharged untreated or partly treated into rivers and coastal seas. These receiving waters are often used by urban residents and tourists as bathing sites and there is a potential for communicable disease transmission. Bathers spend considerable periods of time exposed to contaminated water or beaches.
2. There are many communicable diseases which may be transmitted by bathing including gastrointestinal, skin, eye, ear, nose and throat and respiratory infections. The most relevant ones have a low infective dose. A recent review suggests that the methodology used in previous prospective epidemiological studies of bathers may be flawed (Saliba and Helmer 1990). The evidence for clinical ill-health from bathing in contaminated marine waters remains mixed. However, there are EEC microbiological quality standards for

Bathing water of 100 faecal coliforms per 100ml. A proposed dose-response relationship suggests that at this dose there should be 25-40 cases of gastrointestinal symptoms per 1000 people exposed.

Box 14 Picnicking outside Damascus

The Ghouta is a peri-Urban area of Damascus that is famous for its spring tree blossom and shade. Damascenes frequently go there to picnic during the spring and summer months. The entire area is irrigated with untreated sewage that flows in all the rivers and streams (pers. obs, Birley). The sewage water is mostly used to irrigate tree crops, rather than vegetables. A field flooding or ridge and furrow technique is used. The extent of exposure of Damascenes to hazardous water and soil is hard to judge. It is known that some geohelminths are highly prevalent in the community and seasonal outbreaks of cholera are recorded. On the other hand, the community are very aware of the unpleasant nature of the "black water" and try to avoid it. There is presently a project to treat the sewage before discharge. This will render it less offensive but not necessarily more safe. The treated waters may then appeal to bathers and picnickers.

10 Urban health research in developing countries

10.1 Summary

- The Healthy Cities program is described, together with current research priorities including the healthy marketplace concept.
- Determinants of urban health are discussed.
- The perspective of a number of international agencies is outlined, including the World Bank, World Health Organisation and USAID.
- Work on the development of environmental health indicators is summarised.

10.2 Healthy cities

1. The dramatic effect of urbanisation on human health was very clear in the industrial towns of nineteenth century Britain. The great reformers of that time derived solutions in what they called the "the sanitary idea" (Ashton 1992). Later, emphasis shifted from preventive to curative medicine, until a new public health movement emerged. In 1986, the Healthy Cities Project was launched through WHO. An "ecological idea" began to replace "the sanitary idea". For example, the Victorians solved the waste problem by moving it far from where it was created, but as biological systems become overloaded this solution ceases to work and waste must be recycled *in-situ*. The Healthy Cities Project challenges urban communities to create cities that work with natural systems rather than attempting to subdue them. Thus good natural resource management is seminal to good public health.
2. Many studies have demonstrated that poverty and deprivation are strongly associated with ill-health. The studies have compared the relationships between indicators of health and deprivation over small areas of cities and found a close association. A typical health indicator is the standardised mortality ratio of under 65s. A typical deprivation measure combines unemployment, ownership of common goods, occupants per household and tenancy.
3. The healthy cities project emphasised the need for all involved agencies to consider the health promotional potential of their activities. The Healthy Cities Project has set a number of objectives (Goldstein et al. 1995; World Health Organization 1995b). These include:
 - reduce inequalities in access to health services;
 - create physical and social environments that support health,
 - strengthen the community's capacity, capability and opportunity to take action to support health.
4. Some of these objectives are directly addressed by natural resource management research. Others are required to implement that research or ensure that it fulfils its potential. The objectives are achieved by providing a framework that:
 - increases awareness among all municipal authorities;
 - exchanges information and technology between cities;
 - links technical, political and community action by developing new partnerships between government agencies, NGOs, universities and communities.
5. In general, there is little mention of the peri-urban interface in the healthy cities literature. Inter-sectoral collaboration is widely stressed but there is little mention of natural resource management other than sanitation. In the America Region the healthy cities initiative explicitly includes the peri-urban areas. This is because the municipality is the principal administrative unit. There is a Healthy Municipalities Movement network of Healthy Cities has been established in Francophone Africa. It is co-ordinated from Dakar and supported by the Canadian Government. Other projects included Accra, Johannesburg and Dar es Salaam. In Accra, Ghana, a review of health problems has considered sanitation, food hygiene, community involvement, and land use planning. Kumasi has been involved and a focus on sub-district health management teams has been identified. In the European Region, cities that achieve appropriate criteria are designated "healthy cities" and it appears that the designation is valued as political capital.
6. Some of the conclusions and recommendations of the Health Cities Project, to date, include:
 - recognition that the Ministry of Health needs a "foreign/external ministry" section to liaise with other sectors more effectively;
 - need for EIA and HiA for urban development projects,
 - comparison of intra-urban differentials is an effective tool,
 - better co-ordination of urban development activities can be assisted by a municipal health plan.

7. Some of the research priorities identified include the need for
 - environmental health monitoring-normal health indicators do not adequately reflect rapid urbanisation
 - community participation in work of municipal agencies such as solid waste management; J development and use of MIA procedures for use in urban development projects.

10.2.1 Healthy marketplace

1. One area of healthy city concerns with strong linkages to natural resource management is the Healthy Marketplace initiative. The health linkages of many peri-urban markets can be summarised as:

- poor infrastructure (water, toilets, physical layout);
- health conditions of stall-holders and food handlers (availability of health services);
- practices for storage and handling of raw and semi-processed foods;
- safety of street-vended food;
- environmental impacts;
- solid and liquid waste management;
- role of government authorities such as food inspectors;
- consumer education.

2. In many cities, and peri-urban communities, the marketplace can be considered as a commercial and social centre (World Health Organization 1996c). Often it has evolved without planning, infrastructure or consideration of food safety. In consequence, the food sold there is commonly contaminated. But the social role of the market offers an opportunity to educate the consumer about a range of health issues.

3. A HACCP analysis of food safety in the marketplace identified four main hazards:

- food which becomes unsafe during primary production and/or transport and is brought to the market and sold without inspection or control;
- food which becomes unsafe while in the market due to improper handling and storage;
- food which becomes unsafe in the market due to poor environmental conditions,
- food which is misrepresented or adulterated leading to health, nutritional or economic problems for the consumer.

4. It was concluded that infrastructural improvement is not enough. To address the problems identified above, the marketplace must have an organisation structure that involves municipal health authorities. This requires basic laws, inspectors and analytic laboratories as well as hygiene education. Selective and discriminating consumers can create a demand for food safety. This idea is clearly consistent with crop certification. Pilot projects on healthy marketplaces are being undertaken by WHO in various cities. The contact point is the Healthy City Co-ordinator in each WHO Regional Office. *See* food safety p77.

10.3 Determinants of urban health

1. Some 29-45% of urban populations live below absolute poverty levels (Cairncross et al. 1990). Until recently little has been known about the differential health impacts within cities as a consequence of these conditions. Two aspects of the scale of differentials stand out: the large relative differences in health status between the privileged and the deprived in urban environments of developing countries (13 times); and the scale of the population at risk of these inflated death rates (about 50%). A series of studies suggested that difference between neighbourhoods in environmental conditions was associated with larger differentials in child health than household level facilities.

2 There are a number of studies that seek to identify the principal determinants of urban health. Table 29 is an example (Harpham and Tanner 1990).

Table 29: Urban health hazards, determinants and actions modified from Harpbain and Banner 1995

Health hazard	Determinants Vulnerable groups		Action by sector (other than health sector)
communicable disease			
diarrhoea	water, sanitation, hygiene	children	provision of water, sanitation, education
ARI	indoor and outdoor air pollution,	children	housing, legislation, education, infrastructure
Pneumonia/ TB	same	Adults	health sector
STDs including AIDS	changing social context	adults	education
Measles	overcrowding, poor immune	children	health sector
Helminths	housing, sanitation, behaviour	children	provision of water, sanitation, education
Malaria	housing, drainage, climate	all	housing, infrastructure
Skin diseases	water, sanitation, behaviour, housing	children/ youth	health sector
Non-communicable diseases			
Chronic respiratory disease	overcrowding, poor immune status,	All	Legislation
Obstetric deaths	ANC, abortion legislation,	women	legislation
Perinatal deaths	ANC, education	women	health sector
Cancer	lifestyle, smoking, diet (occupation,	adult	pollution control, education
Cardiovascular disease	lifestyle, smoking, diet,	adult	education
Malnutrition	poverty, education, food availability	children	food supply (and security)
Injury			
Traffic	transport and infrastructure	all	legislation, (road design and siting, pedestrian separation, vehicle maintenance)
Occupational	(workplace practices, maintenance	workers	Legislation, monitoring
Violence	alcohol, drugs, social factors	all	(Housing, lighting, police, en aces,
Household	housing and living conditions	children (and elder	
Mental disorders			
Alcoholism and other drug addiction	stress/life events, lack of social support	adults/ youths	Social support

1. Bradley et al reviewed over 100 epidemiological and demographic studies in urban communities concerned with intra-urban differentials in health and mortality (Bradley et al. 1992). Their review excluded studies from rural areas, such as environmental microbiology and disease vector biology, which may be important in a more peri-urban focus. The most vulnerable community groups were women, children and the elderly. Urban children under five had a similar pattern of mortality to rural children, from the same infectious diseases, including diarrhoea, malaria and ARI. In the age group 5-14 injuries associated with traffic were the leading cause of death. In those over 15, injuries associated with violence were the leading cause of death (homicide). In elderly groups, the prevalence of chronic disease was significantly higher among the poor.
2. The review noted that links could be drawn between poverty, or socio-economic status, and mortality without reference to intermediate variables. Table.30 summarises their conclusions about studies of the causes of morbidity.

Table 30 Conclusions of a review by Bradley et al (1992) intra-urban health differences

Gastro-intestinal disease	A range of studies from Asia, Africa and South America indicated a greater prevalence of diarrhoea and helminth infection in environments with poor housing, sanitation and water. Studies did not indicate whether higher socio-economic status conferred protection. An analysis of infant morbidity and mortality and its relation to water accessibility, water quality and sanitation showed some of the strongest associations of environmental variables and disease. Children from households using public standpipes and cesspools were several times more likely to die of diarrhoea than those with in-house piped water and sewerage.
Nutrition	There was a large amount of evidence of intra-urban differentials in nutritional status related to economic status.
Airborne infection	There was a shortage of studies on respiratory diseases. A study from Sao Paulo suggested that there were no differences in acute respiratory infection (ARI) between socio-economic groups. There was evidence that reductions in respiratory impairment of young children was associated with improvements in particulate and sulphur dioxide levels over the same period in Cuatua, Brazil.
Skin and arthropod borne	Studies on skin-borne and arthropod-borne diseases were rare.
Vector-borne diseases	There were few studies which indicated differentials in urban malaria and dengue.
Psychosocial disease and trauma	There was a growing literature on differentials in mental health within cities, which indicated a higher prevalence in low income, physically deteriorated areas.

1. Comparable differentials existed in several studies between squatter settlements and organised housing areas. The clearest associations between housing and health were for ARI and indoor air pollution, diarrhoea and water (supply, storage and hygiene factors), and accidents. However, the correlation between poverty and deficient home environment was so close that separating them as causal factors was difficult.
2. A seminal study by Stephens et al (1994) mapped health and indices of socio-environmental deprivation in metropolitan Accra and Sao Paulo. The health data was sub-divided between communicable, chronic and psychosocial disease. Causes of death were grouped as:- infectious and parasitic disease (including cholera, TB, malaria, hepatitis); diseases of the respiratory system (including acute, pneumonias and chronic); diseases of the circulatory system (including heart failure, hypertension and cardiovascular)-, and external injuries. In Accra, circulatory diseases cause 25% of deaths and have replaced infectious and parasitic diseases as the principal cause, at 18%. Respiratory diseases have maintained their rank of third place but still form 12%. Infectious disease dominate in the under 14 age class and chronic diseases in the elderly. Malaria remained a principal cause of morbidity.
3. The study identified 7 socio-economic zones using three indicators: income per household, population density; and age/ethnicity (related to old and new migrant groups). The study was focused on the metropolitan area and the only clearly peri-urban community was low density middle class. There was a severe disparity in the cost, availability and quality of water between rich and poor zones. Formal solid waste disposal and collection facilities were barely existent for many communities and there was an extreme shortage of toilets. Overcrowding was intense with 5-6 households or 30-34 persons per house in deprived areas compared with 1-2 households or 7-9 persons per house in the better areas. Some 23% of household heads had no formal education in the high density low class areas.
4. Cause specific mortality varied intuitively between socio-environmental zones although there were some surprises. For example, circulatory disease was more important in poorer areas than might be expected. The death rate from circulatory, infectious/parasitic and respiratory diseases was much higher in poorer zones than richer zones. A particular conclusion was that a large burden of disease from infectious and parasitic diseases was avoidable. It was noted that death rates from malaria were much higher in poor areas close to low lying swamps containing relatively clean water than in poor areas further from swamps or without the relatively clean water. The low Living areas were also flood prone and liable to epidemics of cholera and typhoid. It was less easy to explain differentials in modality from respiratory disease although overcrowding seemed an important factor. Similarly, the higher than expected death rates from circulatory disease among poorer residents may be explained by stress plus lack of access to emergency services and limited road infrastructure.
5. Overall it can be concluded that improvements to environmental conditions in poorer neighbourhoods could have a major impact on human health.
6. A related study included a specifically peri-urban community in the Greater Accra Metropolitan Area, referred to as a rural fringe community (Songsore and McGranahan 1993). 68% of the sample surveyed used charcoal as their main cooking fuel and 8% used wood. In the poorest group about 20% used wood. The paper tried to relate respiratory problems to indoor environments but the results were unclear. In all economic groups the majority took some precautions against mosquitoes with 58% of the poorest using mosquito coils and 6% using mosquito nets. There was some evidence of an association of mosquito coil

use and respiratory problems. Similar evidence from Jakarta led to the suggestion that mosquito coil use should be discouraged (Surjadi 1993)

10.4 World Bank

1. A recent review of trends in urban health research suggests that the World Bank has moved away from project support, such as slum upgrading, to building urban management capacity (Harpham and Tanner 1995). This is, in part, a recognition or a failure to achieve city-wide impacts from neighbourhood-based projects. It is a move from project to policy analysis that seeks to enhance the productivity of the poor by improving access to social services, including health services. The review also suggests that structural adjustment policies have had a disproportionate and negative impact on the urban poor. This community are considered particularly vulnerable because they depend on their own labour, rather than other assets and a cash economy. Structural adjustment reduces employment opportunities and raises the price of goods and services. The free market conditions were predicted to enhance the economy of the informal urban (and peri-urban) sector. But it is now suggested that the opposite may have occurred. On the supply side they have lost access to raw materials that are now recycled by the formal sector. On the demand side there has been a contraction in demand from low income wage earners who bought from informal producers.
2. There are a number of Bank reports that illuminate urban health problems. The Banks' lending for urban development has focused on projects with mainly health objectives (Hecht 1995). The 1992 World Development Report emphasised risk factors in the household environment: contaminated drinking water, inadequate sanitation, indoor air pollution from cooking fires. The 1993 Report suggested that these risk factors accounted for 30% of the global burden of disease. It suggested that feasible improvements in the household environment, in cities and rural areas, could avert about 25% of this burden of disease, equivalent to 2.5 million infant deaths per year. Bank studies suggest that even in urban areas the poor have less access and longer waiting times for poorer health services than the non-poor. Inconsistencies between the 1992 and 1993 reports are the subject of a continuing debate (*pers. comm.*).
3. Future issues for the Bank included:
 - identifying interventions with the greatest impact on the urban poor;
 - defining respective responsibilities of urban local government and central agencies such as the Ministry of Health in developing policies and managing health services. In many cases this may depend on the capacity of municipal governments and their legal framework for delegating authority.
4. A recent report emphasises the need for the following perspectives (Listorti 1996a):
 - examine problems within a triple context of public health, environment and pollution;
 - subordinate pollution to human health, not the reverse, as is so common;
 - place the Pollution of poverty on a par with industrial pollution;
 - identify multiple sources for the same health problems to ensure remedial measures do not deal with only part of the problem-
 - seek targeted collaboration among agencies with similar objectives but which typically do not work together.
5. The report contains an annotated literature review which overlaps with the current review (Listorti 1996b; Listorti 1996c). It focuses on Africa and cites a survey of research topics in environmental health in developing countries. This identified 500 projects of which 77% concerned chemical hazard, 26% physical hazard, 10% biological hazard and 10% psychosocial hazards (Levy, 1992, cited by Listorti). It noted that:
 - the health risks of communities living in airsheds and watersheds near industrial concentrations have received relatively little attention compared with in-plant hazards,
 - the tendency to consider occupational health and safety as a separate discipline to environmental health is not valid in peri-urban environments where industries are small or not covered by occupational health and safety regulation;
 - most causes of disease, injury and death in developing countries lie outside the jurisdiction of the health sector. Yet the policies of sectors that exert these direct health impacts are not set by health criteria,
 - there was very little literature combining ecology and public health. There was a need for shared monitoring criteria on contamination of the food chain through agriculture and water pollution. For example, engineering indicators of water quality such as BOD do not correlate well with pathogenicity.

6. Listorti's main recommendations were as follows

- Research is needed on the urbanization of traditional rural diseases and the remedial measures that are practical through infrastructure provision.
- Targeted collaboration is required between the health sector and the sector responsible for creating or resolving a problem. The agriculture and energy sectors were considered particularly important.
- There is a need for rapid environmental health impact assessment procedures.
- Research is needed on nutrition-agriculture-sanitation linkages.

10.5 UNICEF

1. UNICEF has a programme entitled Primary Environmental Care which is part of its Urban Basic Services programme. It focuses on the fulfilment of basic needs through community empowerment (Padmini 1995). It includes safe water supply and liquid and solid waste disposal. It emphasises environmentally sustainable practices such as community hygienic recycling of inorganic wastes, composting organic waste, using hand carts, using compost in urban agriculture, reducing air pollution by using alternative fuels, better stoves and small scale tree planting.

10.6 WHO

1. A background WHO document on strategies for urban health strongly advocates intersectoral action to improve environments that determine health (World Health Organization 1991 b).
2. Key issues were the increased risks of communicable disease due to overcrowding and immigration as well as increasing vector populations associated with changing settlement patterns. The non-communicable diseases were considered to be strongly influenced by pollution. The types of pollution included indoor air pollution from biomass fuels, outdoor air pollution from vehicular emissions and industrial emissions (acid rain), exposure to toxic substances in industry, homes and agriculture and chemical contamination of food, water and air.
3. The risk factors requiring intervention were listed as:
 - rising population growth,
 - poor housing/ squatter settlements,
 - increased density, overcrowding, traffic congestion, loss of open space,
 - increasing urban poverty,
 - pollution of air, water and land from industrialisation, transportation, energy production and use and waste:
 - institutional inability to provide infrastructure for clean water and sanitation, manage wastes, ensure adequate employment, housing, food supply and safety and environmental controls.
4. The 44th World Health Assembly discussed the urban health crisis and the strategies required (World Health Organization 1993b). Resolution WHA 44.27 advocates the assessment of the impact on health of the policies of agencies concerned with energy, food, agriculture and other sectors.

10.7 USAID

1. USAID has attempted to incorporate health activities into other economic development activities since 1961 (Fluty and Lissfelt 1995). Until the late 80's the focus remained largely rural. Since then there have been several urban health projects but these may have not been integrated with more environmental concerns. The most relevant programme associated with the Office of health and Nutrition was entitled Water and Sanitation for Health (WASI 1), initiated in 1980. This project was initially concerned with technical assistance with safe water, sanitation and hygiene education. Later it became concerned with urban waste issues. Later still a comparative health risk assessment programme emerged (Brantly et al 1997) and this is described below.
2. USAID have a specific focus on peri-urban health issues. This programme acknowledges that conventional approaches to delivering services to poor communities has been ineffective (Varlet' et al. 1996). Building infrastructure does not change behaviours which lead to illness and pollution. Subsidised services generate little sense of community and do not engage or strengthen community organisations. In recognition of this experience many agencies have developed participatory approaches that focus on partnerships, community input, local demands, behaviour changes and explore new ways to cover cost. The solutions require cross-sectional collaboration. They move responsibility for services closer to users.
3. In pursuit of this philosophy the Environmental Health Program of USAID (EHP) has developed a "locally based demand" method. This method is partly concerned with willingness-to-pay at the individual level. For example, it is well known that many poor people pay high charges to water vendors in order to obtain

drinking water. The changes are often several times higher than those households with piped water, but represent what that poor community are actually willing to pay. The willingness to pay analysis is linked to a community participation approach which ensures community ownership of infrastructure improvement.

4. The EHP has reviewed the child health risk factors in urban slums (Environmental Health Project 1996). In comparisons of urban and rural health it is now widely accepted that poverty is a significant predictor of urban morbidity and mortality. Comparisons suggest that urban health is better than rural health but such data is misleading as it hides the large differences between rich and poor and the common omission of the poor from the statistics (Environmental Health Project 1996). Malaria, a typically rural disease, is increasingly important in urban settings. Dengue is at epidemic levels and spreading in urban centres. For example, in 1995 a state of emergency was declared in Guatemala and El Salvador because of dengue epidemics. Respiratory diseases are more prevalent in urban than rural areas because overcrowding promotes the transmission of infectious organisms.
5. Table 31 provides an overview of childhood environmental risk factors in urban (and peri-urban) slums. The factors that most clearly may be influenced by natural resource development are indicated by shading. important environmental determinants include: domestic water supply, sanitation, hygienic facilities, food storage and handling, markets, slaughterhouses, cooking facilities, fuel and industrial pollutants (Environmental Health Project 1996). It is widely recognised that many of these factors cannot be addressed by the health services on their own but require a multi-sectoral approach that enables several programmes to attack the various environmental causes of ill-health simultaneously. These programmes often compete for resources but require methods for sharing resources. This has been referred to as the integration of primary health and environmental care.

Table 31 Child health risk factors in urban slums Environmental Health Project 1996)

Risk factor	Diseases			Deaths
	ARI	Diarrhoea	Malaria	
poor water quality				
poor sanitation		x		
insufficient garbage collection/disposal		x		
poor drainage/ free-standing			x	
crowding	x			
air pollution in and	x			
poor nutrition	x	x		x
poverty	x	x	x	x
low maternal education				x
lack of nearby primary health care				x

1. The EHP have produced a Strategic Framework for 1995-1999 (Environmental Health Project 1995). It covers similar ground to this report with regard to urban/rural differences and transitional economies and then provides an analysis of environmental health burdens, trends and approaches for each developing region, including Africa, Asia and the Near East. It draws on the World Bank concept of Disability Adjusted Life Years (DALYs) to distinguish trends and establish priorities.
2. India is characterised as having severe environmental health problems associated with both traditional diseases such as malaria, typhoid, dengue, Japanese encephalitis and diarrhoeal diseases as well as modern diseases associated with poor industrial waste disposal and rising air pollution. The main trends are rapid population growth and urbanisation. Seasonal urban migration of farm workers is common and brings rural communicable diseases into the cities. Urban water supply and sanitation systems are inadequate and becoming more so. There has been an increase in economic deregulation, free enterprise and foreign investment. This has produced a capable middle class, industrial growth, rising consumption and increased waste disposal problems. Options for improving environmental health are summarised as: -;
 - supporting local capacity to set priorities by introducing tools like environmental health risk assessment;
 - focusing on vector-borne diseases, using community-based approaches-
 - focusing on urban areas, fostering community involvement and institutional development.
3. Africa is regarded as still maintaining the characteristics, in general, of a pre-transition society. it is one of the least urbanised regions and will remain so for the next generation. By 2020 some 40% of the population will live in urban centres. Political disturbances have caused whole groups to move to peri-urban areas and establish "urban villages", preserving their culture and community but experiencing a

radically different environment. EHP proposes to focus on rural problems but also notes that there is more opportunity to address the problems of urbanisation because it is happening as a slower speed. The effect of urbanisation on malaria in Africa requires attention

4. The Framework refers specifically to the peri-urban sector in relation to the Near/Middle East and Latin America, where rapid population growth and urbanisation create a great need for urban environmental health. In the Near/Middle East, water conservation and wastewater reuse are priorities. In Latin America and the Caribbean it is estimated that the peri-urban population will grow from 10-20% in the early 1990's to 40% of the total population by the year 2000. Little of the urbanisation is planned and infrastructure lags far behind. Some 60-80% of urban populations breathe air of marginal or unacceptable quality.
5. The overall EHP Strategy is to promote sustained wellness by reducing risks. The key to this is seen as bridging or promoting collaboration between public health and institutions concerned with environmental improvement. This includes promoting health impact assessment as part of environmental impact assessment.
6. A recent paper addressed the specific needs for environmental health of peri-urban populations in relation to municipal roles and responsibilities (Yacoob and Kelly 1997). The paper starts by noting that the peri-urban poor are often ignored, misunderstood and denied access to public moneys. Efforts by government to improve the living conditions are often ineffective. Part of the reason is administrative complexity. The solution is multi-sectoral and requires new partnerships. The new participatory approach is referred to as Community Involvement in Management of Environmental Pollution (CIMEP). The objective is to extend and maintain basic pollution preventing infrastructure. The project works on changing municipal and community perceptions and behaviour. For example, municipal authorities may mistakenly believe that "participation" means communities supplying free labour for centrally planned projects. On the other hand, communities may believe "participation" means municipalities supplying them with free infrastructure. CIMEP tried to provide a framework in which both sides can work out new partnerships. The project provided training in multi-sectoral collaboration and rapid appraisal using social survey techniques including community mapping. The paper describes the specific interventions that the community identified as priorities through the process and the subsequent outcomes.

10.7.1 Comparative risk assessment

1. Comparative health risk assessment is a method used by USAID to assist public health and environmental officials to set priorities and make sound funding decisions (Brantly et al. 1997). The output of a comparative health risk assessment is a ranking of environmental health problems into high, medium and low risk categories with a comparison between richer and poorer urban areas. Risk levels were classified by considering the two dimensions of probability of effect and severity of effect. Events with low probability and low severity were considered to have low risk.
2. The method builds on health risk assessment. Health risk assessment uses exposure assessment and dose-response assessment to characterise risks as the number of new cases of a disease in a year for a population exposed to a given dose. It is oriented towards diseases in which a dose-response model can be postulated, the post transition diseases. Comparative health risk assessment is a modification of comparative risk assessment that can be used for the pre-transitional or communicable diseases, for which no dose-response relationship exists. It can also cope with the less reliable data that is generally all that is available.
3. A series of studies have been made using the technique. In each study the potential health impacts of a range of problems were identified and then ranked according to their predicted magnitude. Most of the data used was secondary. Primary data was generated only from ethnographic, or social, survey. Such survey work is considered particularly important in peri-urban neighbourhoods where official environmental data rarely exist. It used focus group discussions, key informant interview and semi-structured observation.
4. The method is oriented towards environmental impact rather than social impact and does not currently include malnutrition, injuries and mental disorder. Recent attempts to address these issues have focused on increasing community participation in setting priorities and implementing solutions.

10.8 GTZ

1. rNlerkle (1995) suggests that during 1960-70's health in the city was neglected in favour of a concentration on rural programmes that were expected to reduce urban migration, but this did not happen. Urban statistics disguised differentials between the rich and poor. The health impact of industrialisation, modernisation and uncontrolled growth was not recognised. Since 1980, GTZ has implemented a number of urban health and health related projects, including water and waste.

2. Merkle proposed that four types of areas in cities should be distinguished:
 - Old centres with high population density, decaying buildings, outdated services and informal production sectors;
 - planned middle class areas with moderate population density and adequate services;
 - prosperous elite areas with low population densities and all services;
 - peri-urban areas which are undefined, densely populated, mixed with industries and fast growing. The communities in the peri-urban areas fall into three categories: legally accepted settlements, illegal squatters and a floating population.
3. important characteristics of urban growth included environmental hazards and toxic waste and unplanned growth. Environmental hazards and toxic waste are present at the workplace, home and everywhere in the city, often spilling into astral areas. The author surmises that they cause more morbidity than communicable diseases. Leading problems are: poor solid waste disposal, unsafe water supply and sanitation, inadequate housing and hygiene, exposure to toxic substances and pollution, poor food safety, social and mental stress. The author suggests that city administrations have been unable to cope with unplanned growth and have lost control over large parts of the city. Existing laws and regulations are bypassed and city planning is manipulated by powerful groups.
4. GTZ have carried out a number of baseline health surveys among the urban poor. These surveys have included nutrition, morbidity, a KAP study about water and sanitation and intestinal parasitism, a KAY study about dengue and a survey of hospital waste. The surveys have concluded that accidental injury, homicide and suicide may be leading causes of death. Morbidity was dominated by accidental and violent injury, STDs, substance abuse and psychosocial problems.
5. The nutritional surveys indicated:
 - greater diversity of foods but reliance on purchases of cheap foods with insecurity associated with price and income fluctuation;
 - hazards from street food;
 - inappropriate supplementary feeding of infants;
 - 80% of young children receive three or fewer meals per day;
 - High prevalence of diarrhoea, approximately 20% of children <5.
6. GTZ's experience has led them to rethink conventional approaches to health improvement. Health services should be community oriented, meeting their clients needs in their own time and place. Activities should not be restricted to health services but should include factors like income generation and housing. Laws and regulations are now considered less effective than support and incentives to develop a healthier environment. Health programmes have to become intersectoral. Various actions are proposed including an analysis of health hazards arising from environments and occupations and health advocacy among intersectoral groups. Primary environmental care was considered to have an important role and was described as a process by which individuals and communities learn to understand the effect of constructed environments and develop responsibility for environmental care.

10.9 IDRC

1. The Canadian IDRC has a health and environment programme that shares a similar philosophy to USAID (Forget 1997). They seek to promote community participation and empowerment to set research priorities and choose solutions. The important health issues for the city are identified as interfaces between three determinants of health. These are production activities, socio-behavioural determinants and environmental determinants. The primary health issues were considered to be:
 - pollution by toxic chemicals at the environment-production interface;
 - faecal contamination and vector breeding sites at the behaviour-environment interface; and
 - occupational disease and injury at the behaviour-production interface.
2. In 1997 the IDRC prepared a proposal to stimulate research into urban agriculture (Mougeot 1997). There are several references to the need for health risk research, including the following:
 - locally adequate risk assessment, regulation and enforcement to prevent food contamination; J
 - promotion of space-confined micronutrient self-production,
 - nutritional benefits of self-production for household members;
 - toxicological health risks from plant uptake of heavy metals;
 - safe methods of using wastewater;
 - low cost wastewater technology.

10.10 IIED

1. The IIED has a long programme of research and publication on urban health, much of it under the leadership of Dr Satterthwaite. A recent paper examines the impact on health of environmental problems in urban areas of the third world (Satterthwaite 1993). It identifies the natural resources essential for health as food, uncontaminated drinking water, fuel and safe land sites for dwellings. It also identifies the interaction of environmental, social, economic and political factors in influencing health in urban areas. City populations provide an opportunity for cost-effective provision of infrastructure and services. But in the absence of effective planning, rapidly growing populations can exacerbate environmental health problems.
2. The paper stresses the quality of housing as an influence on respiratory disease through over-crowding, poor ventilation, dampness and indoor air pollution from coal or biomass fuels. Acute respiratory infections, including measles or pneumonia, remain one of the main causes of child mortality. The incidence of tuberculosis is also linked to overcrowded conditions in poor urban areas. Within the home there are interconnections between water, sanitation, animals, personal hygiene and food that create risks of diarrhoea.
3. Atkinson (1993) summarised contributions by many authors to a workshop on urban health without citing individual contributors. The workshop concluded that opportunities for improving health existed in the wider planning context by:
 - supporting economic activities among low income groups;
 - creating micro-enterprises to provide environmental services such as solid waste collection and water distribution;
 - resolving legal residence status.

10.11 Mazingera Institute, Kenya

1. The Mazingera Institute conducted a survey of urban food production and cooking fuels in Kenyan towns during 1985 (Lee-Smith et al. 1987). There was no specific classification according to "peri-urbaness". More than half the urban farmers were women. The report includes some health data. Perceived causes of ill-health in children were primarily ARI, fever (presumed malaria), and diarrhoea. Families rarely used traditional healers but relied on health centres or modern medicines. The respondents typically grew some of their own food, kept livestock and used charcoal for cooking. Fuel shortages had caused about 10% to change their cooking habits from maize and beans to maize porridge or to pre-cooked foods such as potato chips and bread. These changes seemed to be to a less balanced diet. There was an inverse relation between income and proportion of income spent on fuel. The availability of flush toilets seemed to be a good indicator of income and municipal services. In Nairobi about 30% of respondents had pit latrines and these were illegal. Indigenous wild vegetables were collected or purchased and eaten by a large proportion of respondents. About half the respondents kept livestock and these were mainly poultry followed by goats. Use of commercial agro-chemicals was rare. Only a minority used fertiliser and this did not appear to include wastewater or human waste. Irrigation appeared to be mainly with river or piped water using buckets. Most production was for subsistence rather than market.

10.12 Environmental health indicators

1. There is considerable interest among the health community in the development of environmental health indicators (LHi) that parallels interest in the development of indicators by the natural environment community. Both may have been triggered by statements in Agenda 21 regarding indicators of sustainable development (Kjellstrom and Corvalan 1990).
2. A Health and Environmental Analysis for Decision-making, Project (HEADLAMP) was established by WHO in 1993 in collaboration with I S:UD and UNEP (Anon. 1995; Corvalan and Kjellstrom 1995). The project is concerned with the quantifiable linkage between environmental pollution and health outcomes. It seeks to determine whether routinely collected environmental data, such as the Global Environment Monitoring System (GEMS), can be associated with routinely collected public health data. It also uses rapid survey methods. Pollution of air, water, food or soil is included as is the general, occupational and domestic environment. Both traditional and modern sources of pollution are included. For example, the project is concerned with indoor air pollution from biomass fuels as well as fossil fuels. The type of health problem considered tends to be amenable to the dose-response method of analysis where functional relationships have already been established. The method is being used in conjunction with intra-urban differential studies. For example, a study of Sao Paulo suggested that air pollution is monitored for the city as a whole but has relatively little effect on health compared with the large intra-urban environmental

differentials that are associated with large health differentials, but are not routinely monitored (Stephens et al (1995a))

3. HEADLAMB seeks to promote the development of environmental health indicators (fall). These indicators may be derived from routine health or environmental data or survey techniques. One pilot scheme is referred to as a Community-Based Environmental Management Information System (CEMIS) and was tested in Accra (Son-sore and Goldstein 1990)
4. Kolsky and Blumenthal discuss the impracticality of using routine health and environment data to quantify the health burden of poor water and sanitation (Kolsky and Blumenthal 1995). The problem is one of multiple routes of infection, many of which depend on individual behaviour, and methodological difficulties of measuring exposure. They propose, instead, the development of environmental health indicators for sanitation-related disease. The main uses of such indicators are to set priorities for action rather than to establish functional relationships between exposure and disease. The priorities should be objective rather than biased by the specialist knowledge of the investigator. They argue that indicators are available for modern health risks more readily than for traditional health risks. They stress the need to develop indicators based on the communities own priorities. Indicators should be constructed that are based on a mixture of heuristics and rigorous epidemiological research. Examples of the kinds of data that could be collected include:
 - access to water,
 - hours/day of available piped water supply;
 - excreta disposal type and share;
 - price and demand for soap;
 - proportion of streets that are paved;
 - persons/room-
 - proportion of houses affected by floodwaters;
 - faecal coliforms/100m1 of consumed water;
 - disposal practices for children's faeces.
5. Such indicators must be scientifically and causally associated with health outcomes if they are to be of value (Kjellstrom and Corvalan 1995). Static and dynamic and descriptive and analytic indicators can be distinguished. Dynamic indicators would indicate trends. Analytic indicators would reflect an exposure-effect relationship. Analytic indicators can be fitted into a plausible causal chain relationship between the generation of pollutant, the exposure of the community and the health outcome. Various definitions of EFII have been proposed and all share the concept of providing information that guides decision makers actions towards reductions in environmental health risks. Appropriate indicators have not yet been widely agreed.
6. Wills and Briggs reviewed the environment and health indicators that have been developed and refer to natural resource indicators (Wills and Briggs 1995). They identified 233 indicators from 26 indicator projects world-wide. Most of these were environmental rather than health oriented, for example "wild salmon runs through local streams". They distinguished health-related environmental indicators (environmental conditions suggesting potential health effects) from environment-related health indicators (health outcomes suggesting environmental causes). They concluded that most of the environmental indicators in their survey were unsuitable for health analysis.
7. Stephens and Harpharn discuss the methodological problems, including confounding factors, inherent in household surveys designed to link environment and health indicators (Stephens and Harpham 1992).

It may be concluded that a potentially important researchable theme for NR managers is the development of environment and health indicators to measure the health state of the peri-ur ban environment.

11. The Hubli-Dharwad and Kumasi case studies

1. The peri-urban interface programme has focused on two case study cities: Hubli-Dharwad in India and Kumasi, in Ghana. The following descriptions are drawn from the baseline studies and indicate some of the health hazards that are of concern.

11.1 Hubli-Dharwad

1. The Hubli-Dharwad inception report defines the peri-urban interface tentatively as that socio-economic, ecological and spatial region where interactions between the city and its hinterland are dense, multiple and complex and where the city's human and ecological impact is substantial (Natural Resources Systems Programme 1997). This led to the definition of several geographical areas:

- municipal corporation boundary;
- urban development authority boundary;
- limit of city bus travel;
- outer undefined ring.

2. The initial list of issues identified within these rings included'

- pollution of surface water by domestic and industrial waste,
- use of unprocessed sewage for vegetables and other crops;
- landfill sites for nightsoil and garbage, accessed by pigs and scavengers,
- demand for high value products including milk products, meat, vegetables and fruit;
- reducing firewood demand;
- intensification of agro-chemical use;
- increase in tractor usage.

3. Three production systems were described: metropolitan, 20-25km belt and outer belt. The metropolitan system consisted of villages engulfed by urban expansion. Relevant activities included: urban dairy; urban scavenging pigs, poultry units; migratory sheep; goatherds; intensive vegetable production; brick production and stone quarrying; factories; crafts, aquaculture; garbage tips; night soil tips.

4. The 20-25 km belt consisted of orchards, dryland agriculture; irrigation; and villages that were both off and on main roads. The outer belt consisted of forest fringe, forest communities and other production.

5. The report noted that pigs consume a large but unknown proportion of street garbage. The associated hazards of encephalitis and cystercercosis were noted. A need for improved pig production systems was suggested. There were some municipal waste management proposals and their relative health effects need discussion.

6. Fuelwood was being replaced by LPG but was still extensively used. Cotton stalks were an important domestic fuel and also used for bricks and pots. There were plans and projects involving biogas. In other parts of India, forest encroachment has been associated with tick-borne disease outbreaks. Industrial pollution was mainly associated with emissions from a paper mill and road traffic. Many streams were polluted by domestic effluent. There was concern that tanks used for human or cattle drinking water were polluted. There was concern about the falling level of groundwater but no reference to groundwater pollution.

7. Various organisations with NR management interests were identified and their information requirements and jurisdictions are to be determined. There was an institutional transition from rural to urban.

8. Other issues identified included encroachment on sensitive areas such as river boundaries, deforestation on and commodity flows. It was suggested that watershed management should be included in the study as an approach to understanding water inflows to and sewage outflows from the city.

11.2 Kumasi

1. The Kumasi peri-urban baseline study defines the peri-urban interface by the characteristics of strong-urban influences, easy access to markets, services and other inputs, ready supplies of labour, relative shortages of land and risks from pollution and urban growth (Holland et al. 1996).

2. Two geographical zones were identified: a zone of direct impact and a wider market related zone.

3. The zone of direct impact consisted of near urban villages which experience direct urban influences such as land demands and pollution. The "peri-urbaness" of a village was judged by the presence of agricultural

land but with competition from non-agricultural uses. The decision on how far to track the market relationships in the wider market related zone of influence was left open.

4. The main local natural resource issues identified by the main stakeholders were:

- solid and liquid waste disposal,
- the importance of livestock,
- increasing importance of horticulture and increased agrochemical use,
- land use competition,
- labour markets.
- mains electricity supply.

11.2.1 Energy

1. Charcoal was the most common fuel (93% of households) with fuelwood, sawdust, electricity, gas, and kerosene used in lesser amounts (the last 3 limited by supply). Fuelwood was preferred at the periphery, where it was cheaper and accessible. Respiratory disease hazards associated with charcoal use were noted. The use of cleaner fuels such as LPG was encouraged by subsidies but was still very low. There were large quantities of biomass available and these included sawmill wastes and domestic and market refuse. Some experimental work had been done on biogas converters. The rapid increase in powered vehicle transport and low density growth of the city were considered to have implications for future energy sustainability.

11.2.2 Town and country planning

1. Maps and plans provided the main component of the legal framework for physical development of land, an opportunity to reserve a space for particular land use and to co-ordinate development activities. The enforcement of the provisions of the latest (1963) town map for Kumasi had been ineffective. There were no town maps for surrounding districts. The proposed Urban Transport and Urban Environmental Sanitation Projects supported by the World Bank were expected to review the whole development control system.
2. The preparation of planning layouts for particular sectors of the city was a legal requirement under the Planning Act and should control planning approval. However, these had tended to be slow and follow rather than precede development. They had taken little account of livelihood requirements of local residents, such as need for agricultural land. There had been little or no co-ordination of plot layouts with the provision of necessary services by statutory agencies, such as water supply. The development initiative in Kumasi had been taken by householders, chiefs, and statutory bodies for water and electricity supply pursuing business plans. This had resulted in large scale encroachment on land reserved for agriculture, community and recreational uses.
3. There was a high density city centre with rapid construction of low density new housing (7% of housing using 50% of developed land). This had implications for the high cost of providing water and sanitation services. There was a large amount of temporary cropping on construction plots. Land was administered at village level by Stool Chiefs and this included holding land for the benefit of village development. On the other hand, increasing land sales by chiefs to wealthy individuals for residential development was leading to a loss of agricultural land.

11.2.3 Forest and fisheries

Forest products other than timber included charcoal and firewood. Some small fish farms with vegetable production had been established and there was a potential for contamination by agro-chemicals chemicals. Little information on current levels of pesticides in water or fish was available.

11.2.4 Agriculture

A series of different agricultural systems were identified. In bush-fallow intercropped food systems there was little use of chemical fertilisers, pesticides and organic manure. Fallow periods had shortened and become ineffective. In mixed valley bottom soil fertility and pest management practices were rare. Heavy organic pollution of some peri-urban streams favours lush growth of taro-yam. Public health implications were raised. Specialised intensive valley bottom vegetable farms frequently used fertilisers and pesticides leading to watercourse contamination. In backyard farms there was frequent use of manure, black soil (composted town waste from old tips) and inorganic fertilisers. There were increasing pressures towards intensification in many of the agricultural systems. There were concerns about heavy metal accumulation in vegetables. These included lead, mercury, cadmium and copper in water, soil and vegetables grown around Lake Bosomtwe. Some sampling and analysis had taken place but no results were available.

11.2.5 Processing and storage of crops and meat

Processing of crops was usually at the household level and often by hand. Small scale improved technology was used.

This Included electrically powered maize mills Graters and screw presses were used for cassava meal processing and the associated occupational hazards were noted. The only large scale food processing plants were breweries. Small scale production of cooked food for sale was an important economic activity for women. There was extensive and large scale meat processing of cattle from all over northern Ghana. The associated food safety hazards were noted.

11.2.6 Livestock

Urban livestock included sheep, goats, milk and beef cattle. These were usually penned and fed on household food scraps or grazed on crop residues, pasture or refuse. In the peri-urban areas there were medium sized livestock farms fed on scraps, brewers grains. There were also commercial poultry production systems fed on imported feed.

11.2.7 Pollution sources

There was limited access to clean drinking water beyond the reticulated piped water supply. A series of local university studies found the quality of several watercourses in Kumasi to be poor with pollutant levels higher than WHO standards. The main city water supply reservoirs were polluted by wastewater from peri-urban drains and from municipal dumping of sewage. For example, the KMA waste department collects and disposes nightsoil by tipping into the Nsibun River. Waste petroleum products from vehicle disassembly were contaminating groundwater draining into Owabi reservoir. Pesticide contamination was a probable but unmeasured effect of intensive crop production and there are studies in progress. Other sources of water pollution included residues from the soap works and sawmill wastes. All major streams had been found to harbour the snail vector of schistosomiasis. Air pollution was caused by charcoal burning using sawmill offcuts. Soil pollution concerns included arsenic contamination from gold mining activities at Obuasi.

11.2.8 Waste management

1. There were problems with municipal collection and disposal of organic wastes leading to a large number of peri-urban environmental and health impacts. At least one dump site for household wastes was situated above the headwaters of a stream supplying a city district. Proposals for an Environmental Sanitation Programme with the World Bank would provide controlled landfill, composting of nightsoil, solid waste and market wastes and a wastewater treatment plant. There was some village level waste management but limited reuse. There was a private sector waste recycling network. This included dump site scavenging and collection or purchase of glass, plastic bottles and food waste for animal feed. These products were sold in the central market.
2. Concern was expressed about the health hazards of waste utilisation strategies. These included:
 - industrial/agro-industrial wastes as soil improvers;
 - poultry manure from commercial is used by intensive horticulturists;
 - sawmill waste;
 - market and city centre organic wastes contaminated with non-combustibles;
 - old dump sites planted with bananas and latrine sites planted with vegetables.
3. There was generally a lack of detailed information about pollution sources and the value of waste, water and land for agricultural use. An NRI study in early 1997 has started to establish environmental and NR indicators. A GIS project is underway and this will include many layers of information A meta-database is being prepared. There is a challenge to determine how this database can be used *for* health research and intervention

11.2.9 Concerns of key informants

The health related concerns of key informants included:

- contamination of starch foods with poor quality water,
- the safety of human and animal faeces in compost;
- loss of medicinal plants and wild foods;
- reduction in child care when women have to switch to increased tillage of cash crops; U child labour used for hoeing;
- land tenure and support for on-farm infrastructure such as toilets;
- the specific health hazards associated with urban livestock such as cows.

11.3 ODA (DFID) natural resources research strategy

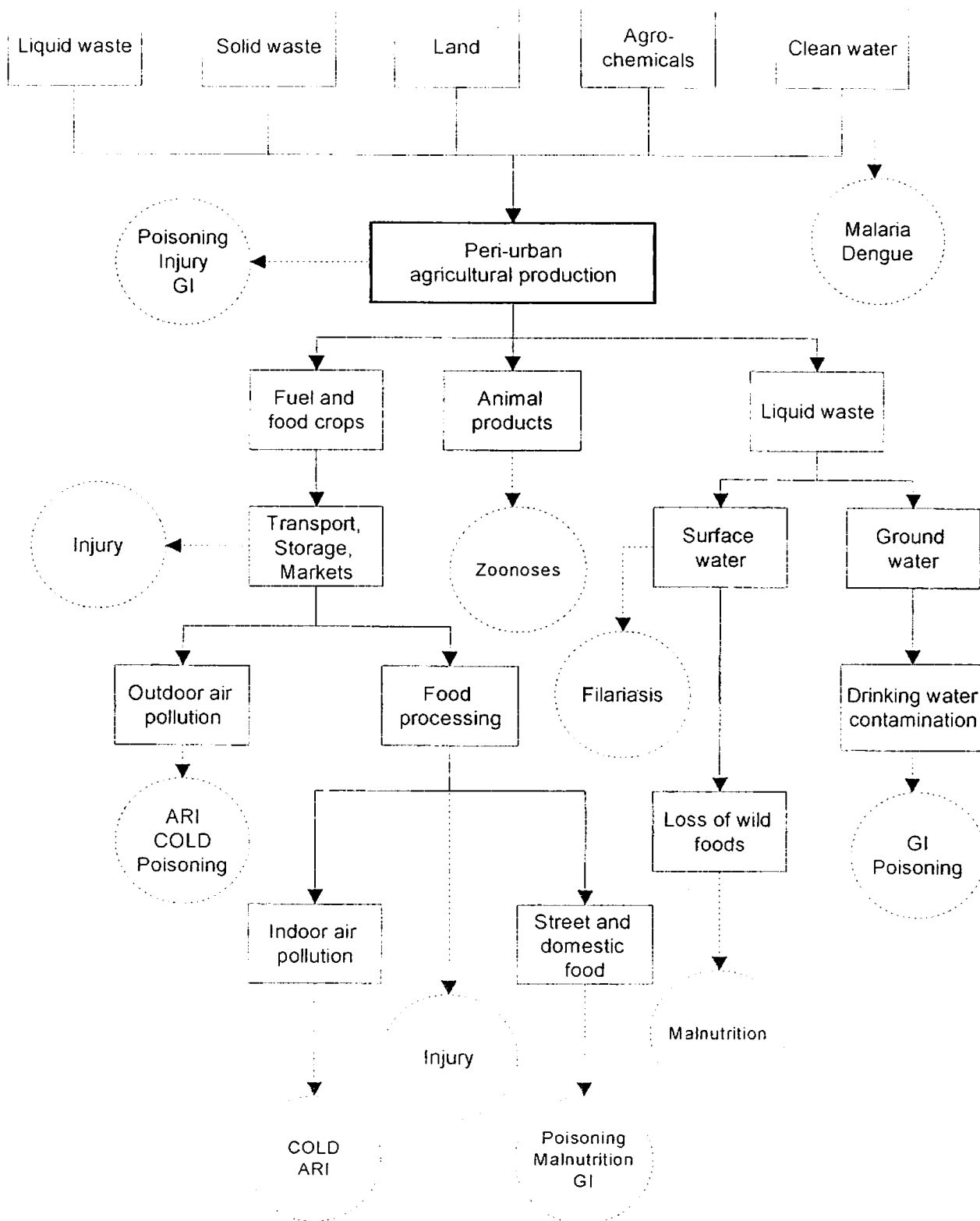
1. The renewable natural resources research strategy contains a number of references of relevance to human health. The socio-Economic research programme, now part of NRSP, has identified how NGO's can support poor urban women in Africa. It found that support was required in: providing credit, providing training in skills and awareness (literacy, hygiene, family planning), work and legal rights. It has observed how poor women traded natural resources imported from their rural home areas and also depended on urban farming although this was constrained by space and water.
2. The crop post-harvest programme is concerned with the distribution chain of marketed crops. Poor management often means high losses of valuable crops through poor storage. There is a proposal to research the needs of rural and urban poor communities so as to improve their opportunity to recoup their investments in time and energy. There is a special concern for women and children and the consequences of using new technologies. In Ghana, there is a special interest in vegetable gardening, tomatoes and eggplants, for national and international market. Mycotoxin control in oilseed and cereals remains an active research interest. A low cost sampling technique and a chemical detoxification process have been developed.
3. Forestry research programme is concerned with the protection of catchments and has indirect benefits for water supplies for urban areas.
4. Livestock production programme has new projects planned to describe livestock production in PU systems and how research needs differ from rural systems. Safe meat and milk production [may be relevant.
5. The fisheries programme does not mention the PUI It does include a post harvest programme which is concerned about unsafe pesticide application to protect stored dried fish.

12. Conclusions

Many of the cause, of ill-health in the urban and peri-urban environment are multifactorial. Consequently, single interventions are unlikely to produce measurable improvements. But this does not invalidate the interventions. Many urban health researchers emphasise the need for community based approaches that are by nature multi-sectoral, integrated and address community priorities (Satterthwaite 1990). The challenge for NRSP/PUI, or DFID, is then to develop effective mechanisms for multi-sectoral research and to include health impact assessment with other project appraisal systems.

2. Health hazards emerge in this review as a factor in all natural resource management and development. Figure 4 provides one view, out of many, on the linkages between natural resource flows and health hazards. The natural resource components are indicated by rectangles. The health hazard linkages are indicated by circles. The central pivot in the figure is agricultural production. A series of inputs of natural resources drive this production and five are indicated in the figure. Clean water is highlighted because of its linkage with vector habitats. The outputs of the production include foods, animal products and wastes. These are further subdivided and some of the health linkages are indicated.
3. Several other institutions have activities that are relevant to the theme of this review. Important bilateral agencies include USAID and IDRC. ORSTOM are said to have a peri-urban project in Cote d'Ivoire, but this has not been confirmed. The multilateral CGIAR system, which specialises in agricultural production, is taking an increasing interest in the health impacts of its activities. Examples include IIMI, IRRI, WARDA and ISNAR. It is not clear whether the CGIAR's have a specific interest in the peri-urban interface. FAO have a specific peri-urban interest in relation to animal production. Within this programme there is general interest in zoonoses.

Figure 4. Some natural resource – health linkages in the peri-urban environment



KEY

ARI= Acute respiratory infection
 COLD = Chronic obstructive lung disease
 GI = Gastro-intestinal infection

13 Recommendations

13.1 Summary

This review of the literature associated with the health impacts of peri-urban natural resource development has highlighted a number of researchable themes. These are collected in the remaining sections. They include the items in the following list

- Effect of urban agriculture on psycho-social disorders.
- Food plant uptake of pollutants.
- Integration of health issues in GIS overlay.
- Occupational health and safety of using biomass fuels.
- Post-harvest decontamination of food crops.
- Safe aquaculture systems.
- The rural-urban transition in relation to various health risks including malaria, respiratory illness and diarrhoea.
- Wastewater reuse.
- Wood fuel from waste.

13.2 Aquaculture

Aquaculture is one of the fastest growing areas for increasing production. There are many health concerns that require further research. Priorities for safe fish production systems have not yet been established and there may be a need for epidemiological studies.

13.3 Biomass fuels

1. FAO suggested that relatively little work has been done on the occupational health and safety of workers in cottage industries, industries, and institutions that use biomass fuels. Industrial examples include brickmakers and ceramic factories. Institutions include schools and hospitals.
2. There is a continuing interest in improving cooking stoves and kitchens so as to reduce indoor air pollution and a detailed proposal has been put to funding agencies by Dr Bruce and colleagues for measuring the health benefits of such interventions. They are seeking suitable field sites.
3. Listorti (1996) suggested that under-researched areas include the cost implication on nutrition of fuel prices, and the contribution of tobacco smoking to indoor air pollution mainly caused by biomass fuels.

13.4 Decontamination of food crops

There is widespread agreement that further work is required on the post harvest decontamination of food crops. This may include individual actions in the kitchen or mass decontamination in the market. Mass decontamination might be sustainable if it created a perceived market advantage for the produce. Crop certification is a related issue.

13.5 Food fuels, cooking stoves and wastewater

Wood fuel crops provide a safe method of using untreated wastewater. Promotion of fuel wood plantations grown with wastewater could usefully be linked with promotion of cooking stoves which reduce indoor air pollution

13.6 Food safety

There have been a number of studies of food safety in the urban environment, often using the HACCP method. No studies were detected which compared the safety of similar foods along the rural-urban continuum. This could be referred to as a food quality transition.

13.7 GIS

A GIS project is underway for Kumasi and this will include many layers of Information. A meta-database is being prepared. There is a challenge to determine how this database can be used for health research and intervention.

13.8 Groundwater

Groundwater resources need to be protected from contamination and overuse. Procedures and policies are required that assist municipal authorities to regulate activities that may affect groundwater. This includes use of fertiliser and wastewater in agriculture, well development, liquid waste disposal systems and latrines. The trade-offs between consumption of nitrate and pathogen contaminated water may need to be clarified in order to establish practical, rather than ideal, nitrate consumption thresholds for small children.

13.9 Healthy Cities – natural resource linkages

The linkages between the Health Cities and the Natural Resources research and implementation communities appear to be poorly developed. The health Cities documentation, in particular, recommends the need for inter-sectoral action. It is hoped that this review will help to provide a linkage, but further action is clearly needed. This should take the form of a multi-disciplinary conference or workshop with representatives from both communities.

13.10 Intra-urban variability and indicator variables

1. Intra-urban differentials provides an effective comparative tool for studying urban problems, including health. A comparison of indicator variables between wholly urban, peri-urban and wholly rural areas may provide a practical method of combining health with other aspects of the PUI/NRSP.
2. These variables may also be used to provide an objective statistical definition of rural, peri-urban and urban which will facilitate comparisons of health and environmental changes along the continuum. The Livestock Programme of David Silverside at NRI has defined 19 indicators for this purpose and field tested them in Bangladesh.

13.11 IPM

IPM is presented in NRI plans as a solution to a public health problem, as well as agricultural problems. Care should be taken to avoid a trap associated with earlier NRI work on pheromones (Mumford et al. 1997). If health concerns are cited as a justification for research then a later evaluation may seek evidence that a health improvement was an outcome of the project. This will require research and monitoring of the prevalence rate of pesticide poisoning, or proxy indicators, among communities that adopt IPM versus those who do not. There are parallels with IRRI's adoption of IPM in rice which was followed by substantial funding to determine the economic cost of pesticide poisoning. UUU were able to conclude that the extra profit from intensive pesticide use was entirely offset by the economic cost of poisoning (Pingali and Marquez 1990).

13.12 Malaria and other vector-borne diseases

1. There has been no systematic epidemiological survey of malaria in Ghana since the 1960's (G. Barnish *pers. comm.*). It is generally believed that in Africa malaria is more common in rural rather than urban areas and a number of studies have supported this hypothesis. However, little is known about the changing epidemiology of malaria along the rural - peri-urban - urban transition. Research is needed to determine:
 - changes in the ratio of vector species, such as *gambiae/arahiensis*;
 - the relative importance of different types of breeding sites, including vegetable gardens;
 - the effect of different land use types,
 - the protective behaviour adopted by different communities,
 - the capacity, capability and jurisdiction of various health protection services.
2. This research could be incorporated in the future work of the Malaria Work Programme funded by Health and Population Division of DFID. A similar set of information is required for filariasis, dengue and schistosomiasis.

13.13 Pollutants in food crops

1. Guidelines for waste reuse in agriculture and aquaculture were issued by WHO in 1989. Many issues remain unresolved and are the subject of further work. The WELL group at the London School of Hygiene and Tropical Medicine are engaged in epidemiological studies of communities exposed to various levels of pathogens. The number of field sites is small and the study requires extension to new sites.
2. The WHO guidelines did not cover chemical contaminants such as metals. The pertinent issues involve the decontamination of wastewater by soil particles and uptake by the crop. Preliminary acceptable levels have been suggested but require further testing on various soils. Further research is required to clarify the severity and extent of pollutant uptake by food plants. Field experiments will be needed in contrasting peri-urban areas.
3. NR managers should take note of the proposed FAO crop certification programme for reducing the health impacts of wastewater reuse in agriculture. Further research on implementation should be included in the systems programme and will require collaboration between agriculture, irrigation and health specialists. The certification should include water used for production, processing and packing of vegetable crops and some fruits. Improved laboratory techniques will have to be implemented for monitoring human coliforms and nematode eggs.

13.14 Prioritisation of health risks

The general hazards associated with peri-urban agriculture such as pesticide and wastewater use are known. The practical risks associated with these hazards required more assessment by examining, actual food sources, agricultural practices and consumption patterns (Listotti 1996c). Research is needed to compare and contrast community perception of health risks with that of managers and researchers.

13.15 Prospective health impact assessment

Prospective health impact assessment should always be included in project plans and planning procedures. In most cases a simple, rapid assessment based on the principles in this review will suffice. Research is needed to determine the precise requirements of NR project managers and the kind of assessments that they would accept.

13.16 Psychosocial disorders

Does urban agriculture provide a sense of empowerment, or control of defensible space, and hence contribute to stress reduction and reduce the risk of psychosocial disorders?

13.17 Transition theories

The health and other transitions referred to in this review are still hypotheses in the context of the rural/peri-urban/urban transition. They require testing and if proved reasonably correct they may have a useful predictive and planning value. "There may also be important linkages between these transitions. For example, the hypotheses predicts that at the more urban end of the transition the community relies on mechanical transport and are more exposed to the modern health hazards of traffic injury, the effects of outdoor air pollution from vehicle emissions and less exposed to the effects of indoor air pollution. The high cost of the modern fuels leads to a lower quality of nutrition and food safety. At the more rural end of the transition, the community expends time and energy on the collection of biomass, may suffer muscular-skeletal damage from carrying heavy weights and is exposed to indoor air pollution from biomass fuels used in traditional kitchens.

13.18 Urban agriculture

More data is needed on a set of issues related to urban agriculture, including the following.

- The communicable disease hazards associated with irrigation of food crops using wastewater in the peri-urban environment.
- The range of water qualities typically used in a number of cities in the developing world where small farmers exploit available sources of wastewater.
- The residual levels of pathogens such as helminths on produce destined for human consumption.
- The effect on vector breeding.
- The appropriate technical/ water management solutions to reduce the health risk to farmers and the urban public.
- The need for public awareness hygiene programmes.
- The capability, capacity and vigilance of existing health protection agencies towards the health risks posed by these agricultural activities.

13.19 Waste treatment

There is a need for more methods of treating liquid waste including on farm stabilisation ponds, reed beds and artificial wetlands and the research in these areas needs following up.

13.20 Other actions

In order to build links with the health community and emphasise the importance attached to preservation of human health, NRSP should support research and debate by health specialists. This could include sponsorship of the 1998 European Conference on Tropical Medicine where a paper will be presented based on this review.

15. Annex: List of files

This report is written in WORD 6 t6i- mat. All document files have the suffix DOC. The files have been compressed into a ZIP file designed for electronic transmission.

AAMASTER Master document - open this one. Contains whole report, sub-document structure has been removed.

NRI.ENL ENDNOTE PLUS X2.3 bibliographic database file

16. Annex: Methodology and Dissemination 16.1

Methodology adopted to undertake this review

1. The majority of this report consists of a review of health linkages arranged according to NR categories. Information was gathered by key informant interview and literature search. At the outset we created two databases. The first provided a reference management system and used ENDNOTE PLUS software. The second provided a contact management system and was based on ACCESS software. The literature search and analysis was strictly time limited - more documentation was obtained on a wider set of topics than could be processed in the time available. Priority was given to existing reviews.
2. Meetings were arranged with as many potential key informants as possible at institutions such as London School of Hygiene and tropical Medicine, Imperial College, NRI, WHO, FAO, World Bank, USAID, Urban Agriculture Network, World Resources Institute and the Environment and Groundwater Institute. The key Purposes of the programme were discussed with each key informant and notes were taken of potentially interesting references, other contact names and lines of current research.

16.2 Strategies for identifying relevant literature and key informants

1. This is not a systematic review. In our opinion, the systematic review method is only appropriate for single issues and not for the open-ended identification phase of a project. It would be possible to conduct a systematic review, one at a time, of the many issues that we identify. This would be a later project. The purpose of a systematic review might include prioritising the health issues that we have identified.
2. As part of our information gathering phase, a simple questionnaire was circulated that explained the purpose of the project and asked four questions. The questions sought an opinion of the recipient about relevant health issues, lists of relevant publications and possible additional contacts. We encouraged the recipient to forward the questionnaire to their own contacts. When the recipient had no email address the questionnaire was transmitted as a hard copy.
3. The questionnaire was sent directly to 212 people from a wide range of Organizations including NRI, ODA, The World Bank, FAO, WHO, IDRC, USAID, GTZ, SANDEC, CGIAR research centres and universities. The response rate was 31%. Those who supplied information are included in an annex.
4. it was hypothesised that many NGOs may be active in the peri-urban interface because of problems of jurisdiction for municipal authorities. A special survey of NGO's was conducted using members of BOND, an association of British Overseas NGO's for Development.
5. The Web was browsed but a systematic search was not regarded as a priority within the available time constraint.

6. We visited the following relevant www sites:
 - City Farmer: <http://www.cityfarmer.org/urbagnotes1.html#notes>
 - CIRAD: <http://www.cirad.fr/>
 - CGIAR: <http://www.worldbank.org/html/cgiar/centers.html>
 - Environmental Health Project (EHP): <http://www.access.digex.net/~chp/>
 - Food and Agriculture Organization of The United Nations (FAO): <http://www.fao.org/>
 - J International Development Research Centre (IDRC): <http://www.idrc.ca/>
 - One World online (links to many Organizations including NGO's): <http://www.oneworld.org/>
 - The Coalition for Healthier Cities and Communities: <http://www.healthycities.org/cgi-bin/toc.asp>
 - The World Bank: <http://www.worldbank.org/>
 - US Agency for International Development (USAID): <http://www.info.usaid.gov/>
 - USAID environmental links page: <http://www.info.usaid.gov/environment/enric/elinks.htm>
 - United Nations Centre for Human Settlements (UNCHS): <http://www.undp.org/un/habitat>
 - United Nations Environment Programme (UNEP): <http://www.unep.no/>
 - World Health Organization: <http://www.who.ch/>
 - WHO Healthy Cities Project: <http://www.who.dk/tech/hcp/index.htm>
7. We also posted a request for information on the following e-mail discussion lists:
 - INFOTERRA, the email discussion list of the United Nations Environment Program: infoterra@cedar.tinivie.ac.at
 - Mailbase Public Health list: public-health@mailbase.ac.uk
 - City Farmer (urban agriculture).
8. The University of Liverpool and the NRI CD-ROM collection were searched using the logical construct:
9. health AND {peri-urban OR peri-urban OR urban OR outskirts} AND {natural resource OR agriculture OR fuel OR food OR forestry OR livestock OR fish OR waste OR pollution OR recreation}.
10. The databases searched were as follows.
 - MEDLINE - 1991- to date;
 - CAB - 1984 to date -the Commonwealth Agricultural Bureau International disc;
 - TROPAG and RURAL - 1975 to date - the Royal Tropical Institute of the Netherlands disc;
 - AGRIS - 1981 to date - the Food and Agriculture Organization disc,
 - FSTA - 1969 to date- the Food Science and Technology Abstracts disc from the International Food Information Service;
 - AGRICOLA - 1970 to present.
 - SESAME - 1991- the CIRAD database
 - USAID: 1996 - the USAID database
 - CAIRS - the NRI database
11. We also sent our search request to the ODA natural resources database to elicit details of relevant ODA projects and to the AHRTAG bibliographic database for information on air pollution.

16.3 Outputs

Output; to date, of this study have been seminars entitled "the health impact of peri-urban natural resource development" presented at.

The World Bank, Washington;

The annual conference of International Association For Impact Assessment, New Orleans, The Environmental and Groundwater Institute. Oklahoma.

16.4 Dissemination

1. The Environmental Health Group at WHO have a special interest in the dissemination of teaching material on health impact assessment and other environmental health issues. Future collaboration on the dissemination of peri-urban health impact issues may be of mutual interest. The key contact would be Dr T Kjellstrom or his successor. Their current projects include a book on health and environment in sustainable development and the use of indicators for decision making in environmental health. However, the overlap of this project with several different WHO programme areas could cause administrative problems.
2. Dissemination of this report should be primarily through the email and this is the basis on which we have constructed a list of potential recipients. The email should be designed so that the executive summary is in

plain text and the main body of the report is a compressed attachment in Word 6. A disclaimer should be added regarding the spread of computer viruses.

3. A paper based on this report will be published in a peer reviewed journal. There are a number of options. The editor of the journal Environment and Urbanisation has commissioned a paper for the April 1998 issue *which is* devoted to rural-urban *linkages*. This *journal is widely read* by an appropriate *research* community. However, it suffers from the disadvantage of not having a research impact rating and this must discourage publication by university academics.
4. We will also explore the opportunity for publishing a short and popular account in the New Scientist. Publication *in non-impact* rated *sources will* require extra budgetary support.
5. A survey of impact rated journals suggests the following publication

options. **Table 32 Some publications options**

Journal	Impact	Ratio non-review to articles	Conclusion
Annual Review Public Health	2.648	0	Appeared promising, editor contacted 4/7/97. Would involve explaining to health specialists rather than vice versa.
Environment, Washington	2.1815	?	Global issues
Bulletin of WHO	1.535	26	Would not reach a health specialist audience.
Environmental Science Technology	3.122	7.4	Chemical analyses
Environmental Health Perspectives	1.194	69	Pollution bias, worth a try
J Environmental Science and Health	1.128	?	Chemical pollution including agricultural wastes.
Trans Roy Soc Tropical Med and Health	1.149	?	Would only reach a health specialist audience.
Environmental management	.707	112	Possible
Environment and Urbanisation	0	-	Reaches right audience, short commissioned for 1998 issue on rural-linkages,

17 Annex: Glossary

abscess	A cavity containing pus and surrounded by inflamed tissue.
acoustic trauma	Hearing loss, from exposure to continuous loud noise over a period of time or a sudden explosion or blow to the head or other injuries. May be temporary or permanent.
<i>Ae.</i>	Abbreviation of <i>Aedes</i> .
<i>Aedes</i>	A genus of mosquitoes capable of transmitting dengue, yellow fever and encephalitis.
aflatoxicosis	A diseased condition caused by the presence of aflatoxins in the body.
aflatoxin	A class of mycotoxins produced by a mould that grows on damp food.
agro-chemicals	Chemicals used in the agricultural industry such as fertilizer, pesticides and weed killers_
AIDS	Auto Immune Deficiency Syndrome caused by infection with the human immunodeficiency virus.
airshed	A concept used to denote the boundaries of a mass of air. Often used in relation to pollution concentrations.
allergen	Any substance that induces an allergic reaction.
<i>An.</i>	Abbreviation of <i>Anopheles</i> .
anaemia	A condition characterised by a low haemoglobin level in the blood.
analysis	An examination in order to understand. See assessment,
anisakiasis	An infection of the gastrointestinal tract by larval nematodes of the subfamily Anisakidae. People become infected by eating raw or inadequately treated fish.
Anopheline	One of two groups into which mosquitoes are divided.
Anopheles	A genus of mosquitoes that transmit malaria.
antenatal	A time period between conception and birth. It is important for women to have adequate treatment and advice during this time.
anthrax	A bacterial disease caused by the organism <i>Bacillus anthracis</i> .
antimony	A toxic chemical element.
appraisal	A critical examination of an identification report, which selects and ranks the various solutions from: points of relevance, technical, financial and institutional feasibility and socio-economic profitability and precedes the approval by the authorities of the proposed action.
aquatic	Living, growing or taking place in or on water.
arbovirus	An arthropod borne virus.
arsenic	A toxic chemical element.
arthritis	A condition characterised by painful, stiff joints that ultimately damages the joints involved producing considerable morbidity and disability.
arthropod	An animal group including insects, ticks and mites.
asbestos	A fine fibrous mineral that can damage the lungs.
asbestosis	A disease in which the lung tissue thickens in response to irritation by inhaled asbestos fibres and which consequently obstructs respiration.
<i>Ascaris</i>	A genus of large parasitic worms that infest the small and large intestines of humans and animals producing occasional symptoms. Also called roundworm. Found in temperate and tropical regions.
Asian tiger mosquito	Common name for <i>Aedes albopictus</i> .
assessment	An examination in order to decide. See analysis.
axil	The angle between the leaf and the stem. In some plants such as bromeliads water collection in the axil can provide breeding places for mosquitoes.

bacteria	A. class of microscopic: organisms of simple structure that cause many diseases
Bancroftian filariasis	Filariasis caused by the nematode <i>Wucherera bancrofti</i> . See filariasis.
beedi	An indigenous Indian cigarette.
benefit-cost	A term that represents the relationship between the benefits accrued for the cost incurred.
benthic	Adjective of benthos.
benthos	Flora and fauna on the bottom of a water body,
benzene	A carcinogenic liquid, the fumes are irritating to the eyes, mucous membranes and upper respiratory tract and may cause dermatitis.
berm	An earthen bank raised above the ground.
bilharzia	See schistosomiasis.
biofuel	A biological, renewable source of energy.
biomass	Material derived from living matter.
biotopes	The smallest geographical unit of the biosphere or of a habitat that can be delimited by convenient boundaries and is characterised by its flora and fauna.
bivalves	A class of marine or freshwater molluscs,
blue-baby syndrome	A condition, suffered by babies, of insufficient oxygen in the blood. It can be caused by nitrite ingestion.
bromeliads	The family of plants to which the pineapple belongs. They are associated with breeding sites for mosquitoes.
bronchitis	A disease in which the lining of the bronchial tubes of the lungs are inflamed. It may be caused by bacteria, viruses, chemicals and other substances such as asbestos and dusts.
bronchogenic carcinoma	A malignant lung tumour that originates in the bronchi.
browse	The shoots and leaves of plants. Fodder.
brucellosis	A bacterial infection of animals causing abortion. It can be transmitted to man via direct contact or ingestion of dairy products resulting in recurrent or chronic fever. Also called undulant fever.
byssinosis	A lung disease of cotton workers caused by an allergic reaction to dust or fungi in inhaled cotton, flax and hemp fibres,
cadmium	A toxic element.
Campylobacter	A genus of bacteria that causes human infections and abortion and infertility in cattle.
carcinogenic	A substance that induces the development of cancer.
carcinoma	A malignant, abnormal growth of new tissue.
carcinogenicity	Of or pertaining to the ability to cause the development of a cancer.
cardiovascular	Of or pertaining to the heart and blood vessels.
cassava	Tapioca; an edible root. It contains toxic cyanide compounds in its skin and outer layers that need to be leached out during the cooking process.
Chagas	A disease in South America affecting the heart, liver, spleen and colon due to infection with the parasite <i>Trypanosoma</i> .
checklist	A list for verification purposes; a comprehensive List: an inventory.
chemoprophyl axis	The use of antibiotics and chemicals (chemotherapeutants) to prevent the occurrence or spread of a disease in man,
chlorination	A treatment process in which chlorine is used. For example, (1) to sterilise water or (2) to extract gold from ore,
chloroquine	A drug used in the prophylaxis and treatment of malaria. There is increasing resistance in the malaria parasite to chloroquine.
cholera	A highly infectious disease caused by <i>Vibrio cholerae</i> characterised by vomiting and rice water stools leading to rapid dehydration and death. It is spread by the faecal-oral route and contamination of water and food. It is subdivided into two biotypes, cholerae (classical) and El Tor.

chromium	A toxic element that can cause indolent and painful ulcers of the: Skin as well as dermatitis.
chromate	A salt of chromic acid that may be toxic.
chronic	Of a disease or disorder; developing slowly and persisting for a long time or constantly recurring.
ciguatera	A non-bacterial food poisoning caused by eating fish contaminated with ciguatera toxin.
clonorchiasis	A disease caused by the Chinese liver fluke, a human parasite transmitted via intermediate stages in aquatic snails and fish.
<i>Clostridium</i>	A genus of spore-forming anaerobic bacteria. <i>C.botulinum</i> causes botulism food poisoning; <i>C.perfringens</i> causes food poisoning and wound infections; <i>C.tetani</i> causes tetanus.
coir	The strong fibre of coconut husks.
coliforms	A group of bacteria. Some of them, faecal coliforms, are normally found in human and animal faeces
communicable disease	Any disease that is transmitted from a person or animal to another via a host of agents such as insects, foods and contaminated materials.
congenital	Dating from birth. Referring to a disease or deformity caused by defective or inoperative genes.
conjunctivitis	An inflammation of the thin transparent lining of the eye (the conjunctiva). It is caused by viruses, bacteria, chemical substances or degenerative changes.
cor pulmonale	An abnormal condition of the heart characterised by an enlarged right ventricle.
cortical cataract	An eye condition resulting in blurred and distorted vision.
cretinism	A disorder with physical and mental symptoms. Associated with iodine deficiency.
cross-resistance	The development of resistance to different antibiotics, drugs or pesticides of the same or related class by micro-organisms or vectors.
<i>Cryptosporidium</i>	A microscopic organism normally found in the gut of animals. It is capable of producing diarrhoea in humans particularly in immunosuppressed persons.
<i>Cu.</i>	Abbreviation of <i>Culex</i> .
<i>Culex</i>	A genus of mosquitoes that transmit filariasis and viral encephalitis.
culvert	An arched channel beneath a road or railway to carry water.
cysticercosis	An infection with the larval stages of the pork tapeworm <i>Taenia selium</i> . It is acquired by eating inadequately cooked, infected pork.
DDT	An organochlorine based insecticide
demographic	Relating to or pertaining to the study of populations; information about the composition and characteristics of a population.
dengue	An acute tropical fever caused by a virus, occasionally fatal; also known as break-bone fever. The vectors are mosquitoes of the <i>Aedes</i> genus.
dermatitis	An inflammation of the skin usually because of infection or irritation by chemical substances that come in contact with the skin.
diarrhoea	Persistent purging or looseness of bowels commonly due to infection by micro-organisms such as <i>Salmonella</i> .
diabetes mellitus	A complex disorder of carbohydrate, fat and protein metabolism primarily due to a lack of insulin secreted by the pancreas.
dracunculiasis	A parasitic infection caused by infestation by the nematode <i>Dracunculus medinensis</i> . People are infected by drinking contaminated water. Also called guinea worm infection.
draught power	The use of animals to draw heavy loads.

drawdown	The magnitude of the change in water surface level in a well, Reservoir or natural body of water resulting from the withdrawal of water.
dysentery	An inflammation of the large intestine that may be caused by bacteria, protozoa, parasites or chemical irritants. It is characterised by the frequent, bloody stools. Amoebic dysentery is caused by <i>Entamoeba histolytica</i> and bacillary dysentery by <i>Shigella</i> species.
dyspnoea	A shortness of breath. Difficulty in breathing.
ecology	The study of the relationship between communities of organisms and their environment.
effluent	Liquid industrial and agricultural waste; outflowing sewage during purification.
encephalitis	Inflammation of the brain tissue .
endemic	Of a disease or micro-organism: indigenous to a geographic area or population.
enteric	Pertaining to the intestines; enteric fever or typhoid fever is an infectious disease caused by <i>Salmonella typhi</i> characterised by fever, rash, enlarged spleen and ulcers in the intestines.
epidemic	The occurrence in a community or region of cases of an illness, specific health-related behaviour, or other health related events clearly in excess of normal expectancy within a specific area and time period.
epidemiology	The study of the distribution and determinants of health-related states or events in specified populations, and the application of this study to control of health problems.
epiphyte	A plant or animal growing or living on another plant or animal without being parasitic. (Adjective - epiphytic).
<i>Eshenca colt</i>	A species of coliform bacteria normally present in the intestinal tract of humans and animals, and common in water, soil and food. It can be pathogenic causing urinary tract infections, food poisoning and septicaemia.
evaluation	An examination as systematic and objective as possible of an on-going or completed project or programme, its design, implementation and results with the aim of determining its: efficiency, effectiveness, impact, sustainability and relevance of the objectives with the purpose to guide decision-makers.
ex-post	Referring to an evaluation of an intervention after it has been completed with the aim to determine how well the aid has served its purposes and to draw conclusions for similar interventions in the future.
excreta	Faeces and urine.
farmers' lung	A respiratory disorder caused by inhalation of organic dusts from mouldy hay.
faeco-oral	Related to a route of transmission of pathogens that involves food, water or objects contaminated by faecal material entering the mouth.
<i>falciparum</i> malaria	The most severe form of malaria, caused by <i>Plasmodium falciparum</i> .
fallout	A deposit of dust from an explosion or industrial plant.
fasciolopsiasis	A disease caused by the giant intestinal fluke. a human parasite transmitted via intermediate stages in aquatic snails and plants.
feasibility	A measure to prove that the technical options are sustainable and are also the best in that situation.
fertility	The ability to bear or reproduce.
filariasis	A disease caused by the presence of filarial worms in the blood and lymph nodes. The vector is a mosquito.

fluorosis	The condition resulting from excessive, prolonged ingestion of fluorine
Locus	Point or region of greatest activity of a disease and/or its vector Plural - foci.
food security	Access to food for all people at all times, both physically and economically.
foraging	The act of searching for fodder for horses and cattle.
formaldehyde	A disinfectant, preservative and germicide. It is used to make synthetic resins. It is toxic.
fry	A swarm of young fish just spawned.
fuelwood	Wood collected for use as fuel.
fungi	Plants without chlorophyll which include mushrooms, and moulds.
fungicide	A chemical substance that kills fungi.
gastro-enteritis	Inflammation of the lining of the stomach and intestines producing vomiting and diarrhoea caused by infection with micro-organisms or toxins.
genotoxic	A substance which is toxic to genes.
geohelminth	A parasitic worm with part of its life cycle occurring in or on the soil.
genu valgum	A deformity in which the legs are curved inward so that the knees are close together, knocking as the person walks. Also called knock-knee.
giardiasis	An infection caused by the protozoan <i>Giardia lamblia</i> which is spread by contaminated food and water and person to person contact.
goitre	A condition in which the thyroid gland is abnormally enlarged, associated with iodine deficiency.
gonorrhoea	An infection of the genitourinary tract with the bacteria <i>Neisseria gonorrhoeae</i> . It is sexually transmitted.
granuloma	
grass-pea	A type of a legume. <i>Lathyrus sativus</i> , also called the chickling pea. Consumption can cause lathyrism. See also lathyrism.
groundwater	Water that occurs naturally beneath the ground surface and may include the fraction of the precipitation which infiltrates the land surface.
guinea worm	Common name for dracunculiasis.
habitat	The normal abode or locality of an animal or plant, the physical environment of a community; the place where a person or thing can usually be found.
haematuria	The presence of blood in the urine.
haemoglobin	The red oxygen-carrying pigment present in the red blood cell.
harbourage	A place of shelter and refuge; it may be natural or artificial.
hardware	Refers to mechanical equipment or infrastructure.
health hazard	A potential for causing harm to people.
health impact (of a development project)	A change in the frequency of some health indicators among the vulnerable community which is reasonably attributable to the project.
health risk	The possibility that a health hazard will cause harm to a human community. Measure of probability that a hazard will cause harm. As there are great uncertainties, only a simple ranking procedure can be used.
health risk management	Action intended to reduce health risk.
helminth	A parasitic worm.
hepatitis	An inflammatory condition of the liver which may be caused by bacterial, viral or parasitic infection, alcohol, drugs, toxins or transfusion of incompatible blood.

Hepatitis A	A form of infectious viral hepatitis caused by the hepatitis A virus It is spread by direct contact or through contaminated food and water.
hexachlorohexane	An insecticide of the organochloride (organic chemicals containing chloride) group.
hinterland	A region lying inland from a port or an urban centre, or a centre of affluence: terrain on the back of a folded mountain chain.
HIV	Human Immunodeficiency Virus that causes the Auto Immune Deficiency Syndrome (AIDS).
hookworm	A parasitic worm that causes anaemia.
host	An organism, on or in which a parasite lives and feeds.
hydatid disease	Infection with the larval stages of the dog tapeworm <i>Echinoccus granulosus</i> . Infection is acquired through faecal-oral contact and the larvae may migrate to any organ of the body.
hydraulic	Conveying water.
hydrogen sulphide	A gas that can cause asphyxiation,
hyperkeratosis	Thickening of the superficial layer of the skin.
hypoxia	Oxygen deficiency, may be caused by reduced oxygen carrying capacity, insufficient oxygen in inspired air, impaired tissue utilisation of oxygen or inadequate blood flow.
HYV	High Yielding Variety, of agricultural crops.
immunisation	A process that induces or increases the capacity of a person or animal to resist infection.
immuno-suppression	A decrease in the capacity of a person or animal to resist infection.
impact (of a development project)	A term indicating whether the project has had an effect on its surroundings in terms of: technical, economic, socio-cultural, health, institutional and environmental factors.
incidence	The number of cases of a specified disease diagnosed or reported during a defined period of time, divided by the number of persons in the population in which they occurred.
infection	The invasion of the body by pathogenic micro-organisms which multiply causing disease.
infectious	A disease organism capable of causing an infection.
infertility	The inability to bear or produce offspring.
influenza	An acute viral disease of the respiratory tract characterised by the presence of fever and severity of symptoms.
informal sector	Economic activities that are not subject to regulation.
inmigration	Migration inwards to a focal point.
Japanese Encephalitis	A mosquito. borne arbovirus which can cause severe or fatal disease.
jeepney	A small bus characteristic of the Philippines.
jute	A plant fibre used for making sacks and mats
keratitis	An inflammation of the cornea of the eye
kwashiorkor	A nutritional disease of weaning children in the tropics due to a relative deficiency of protein probably as a result of altered protein metabolism
laryngeal	Of or pertaining to the larynx.
larynx	The upper part of the windpipe.
lathyrism	A disease caused by eating the grass-pea, <i>Lathyrus sativus</i> , which contains a toxic chemical substance. If it is consumed in large quantities the nerves in the spinal cord are damaged causing stiffness or paralysis of the lower limbs.
leachate	The products of leaching. See leaching.
leaching	The removal of readily soluble components, such as sulphates and carbonates, from soil by percolating water

Legionnaire's disease	An acute bacterial pneumonia caused by infection with <i>Legionella pneumophila</i> . Moist soil and contaminated air-conditioning cooling towers may be sources of organisms.
leishmaniasis	A disease caused by parasitic protozoa of the genus <i>Leishmania</i> that is transmitted from person to person by sandflies; also known as Kala-azar and Oriental sore.
leptospirosis	A disease caused by bacteria of the species <i>Leptospira</i> . It is transmitted to people by: contact with animals, moist soil, recreational, accidental or occupational immersion in water or vegetation contaminated with urine of infected animals such as pets and rodents.
leukaemia	Cancer of the blood,
listeriosis	An infectious disease caused by the bacteria <i>Listeria monocytogenes</i> .
loiasis	A form of filariasis caused by the worm <i>Loa loa</i> . It is transmitted by African deerfly or horsefly. It occurs in African moist forest.
lymphoma	Cancer of lymphoid tissue.
maloprim	A drug used in malaria prophylaxis.
malaria	A mosquito-borne disease caused by <i>Plasmodium</i> parasites. See also <i>falciparum</i> malaria and <i>vivax</i> malaria.
malnutrition	Under- or over-nourishment. Under-nourishment is a deficiency condition in which one or more necessary nutrients are unavailable in sufficient amounts for normal growth maintenance and health.
marginalization	The process by which a vulnerable population group is moved to the periphery of the socio-economic mainstream.
measles	An infectious viral disease common in children causing fever and a rash.
mefloquine	A drug used in the treatment of malaria, particularly chloroquine resistant malaria.
meningitis	An infection or inflammation of the membranes covering the brain and spinal cord,
meningococcal meningitis	Meningitis caused by the bacterium <i>Neisseria meningitidis</i> .
metastatic	Of or pertaining to the process by which tumour cells are spread to distant parts of the body.
methyl isocyanate	A highly reactive chemical which contains phosgene, a nerve gas.
methyl parathion	A relatively toxic pesticide.
micronutrient	A nutrient necessary for the normal growth and maintenance of the body but required in very small amounts, such as vitamins and minerals like iron and zinc.
migration	The permanent movement of a population from one habitat or location to another.
milch	Giving milk. Usually applied to cows which are kept for milking.
monitoring	A management function which uses a methodical collection of data to determine: whether the material and financial resources are sufficient, whether the people in charge have the necessary technical and personal qualifications; whether activities conform to work plans; and whether the work plan has been achieved and has produced the original objectives. See surveillance. Environmental Monitoring: observation of effects of development projects on environmental resources and values, including sampling and analysis, during construction and operation.
monocrotophos	A relatively toxic pesticide.
monoculture	The cultivation or culture of a single crop or species to the exclusion of others; as in replanting deforested areas with only one or few species.
morbidity	The condition of illness or abnormality; the rate at which an illness occurs in a particular area or population.

mortality	The condition of being subject to death; mortality rate (the death the frequency or number of deaths <i>in any</i> age group. disease or other classification.
muco-cutaneous	Of or pertaining to the mucus membrane and skin.
mutagenic	Inducing genetic mutation(s) or increasing the mutation rate.
mutagenicity	Of or pertaining to the ability to cause genetic mutation.
mycobacteria	A genus of rod -shaped, acid fast bacteria having several significant pathogenic species: <i>Mycobacterium tuberculosis</i> and <i>M.bovis</i> cause tuberculosis and <i>M. leprae</i> causes leprosy.
mycotoxins	Toxins produced by fungi that are harmful e.g. aflatoxin
nasal septum	The partition dividing the nostrils.
neonatal	Refers to the period from birth to 28 days of age.
neoplasm	An abnormal growth of new cells that is unrestrained. It ca be benign or malignant. It is malignant if it invades other tissues of the host or spreads to distant parts.
nephropathy	Any disorder of the kidney, including inflammatory and degenerative conditions.
neuropathy	Nerve damage
neurotoxin	A toxin that has an affinity for the nervous system,
niacin	A member of the Vitamin B group of micronutrients,
nightsoil	A euphemism for human excreta stored in containers which are not connected to sewers. The containers are usually emptied at night and the partially decomposed matter may be used as a fertilizer.
nomadism	A sustainable lifestyle that requires frequent travelling from place to place usually within a well-defined geographical territory.
non-communicable	Cannot be spread from one person to another.
non-immune	Susceptible to a disease.
occupational disease	A disease common among workers engaged in a particular occupation brought about by the conditions of that occupation.
onchocerciasis	A disease caused by the parasitic worm <i>Onchocerca volvulus</i> that is transmitted by black flies; also called river blindness. opencast Relating to a mining process by which the material is excavated from an extensive area of the earth's surface.
<i>Opisthorchis viverrini</i>	A liver fluke acquired by eating inadequately cooked infected fish. Causes chronic liver disease and can be fatal.
organophosphorous	A group of chemicals used as pesticides.
outbreak	A sudden occurrence of, or increase in, cases of a disease in a population in an area or locality.
paludrine	A drug used in malaria prophylaxis.
pandemic	an epidemic of disease of a regional, national or global significance
paralytic shellfish poisoning	A Toxic, neurologic condition that results from eating clams or mussels that have ingested protozoa containing the toxin saxitoxin.
parasite	An organism that lives on or in another organism termed the host, and draws nourishment from it. (Adjective - parasitic)
parathion	An insecticide from the organophosphate group of insecticides.
particulate	Having the form of particles.
pastoralism	The keeping of herds of cattle, goats, sheep or similar animals.
pathogen	An organism that causes disease. Most pathogens are microscopic in size.
peri-urban	Relating to localities bordering a city or other urban area.
phosgene	A suffocating and highly poisonous gas.
phosphine	1. Hydrogen phosphide, a toxic gas. Z A coal tar dye, extremely destructive to some life forms.
pinworm	A common parasitic intestinal nematode (<i>Enterobius vermicularis</i>).

Plaque	A disease caused by infection with the bacillus <i>Yersinia pestis</i> that is usually transmitted from rodents to people by fleas
plume	A narrow column of smoke or noxious gases.
pneumoconiosis	A disease of the lung caused by long-term inhalation of dust, usually mineral dusts of occupational or environmental origin.
pneumonia	An inflammation of the lung caused by pathogenic organisms such as bacteria, viruses and chemicals.
poliomyelitis	A communicable disease caused by one of the three polio viruses that may result in paralysis.
polychlorinated biphenyls	Toxic fluids that are widely used in industry including additives in paints, adhesives and plastics. They are considered a carcinogenic risk to humans (PCBs).
potable water	Water that is palatable and safe for human consumption; in which any toxic substances, pathogenic organisms and factors have been reduced to safe or acceptable levels.
prevalence	The number of people ill because of a particular disease at a particular time in a given population. Often expressed as a rate.
prophylaxis	The methods used to prevent the occurrence of, or progression to disease.
protection agency	A government agency responsible for protecting the health and safety of the community and the environment.
protein-energy	Energy derived from the metabolism of proteins in the human body.
protozoan	A simple single celled animal e.g. <i>Entamoeba histolytica</i>
psittacosis	A type of pneumonia that is transmitted from birds to humans.
pulmonary	Of or pertaining to the lungs or the respiratory system.
pyrethroid	A group of powerful synthetic insecticides.
pyrethrum	A natural insecticide extracted from chrysanthemum flowers.
q fever	An acute febrile illness, usually respiratory, caused by <i>Coxiella burnetii</i> . Humans acquire the disease through contact with infected animals by inhalation (from hides), consuming infected milk or tick bite.
recrudescence	The recurrence of a disease because of reinfection rather than a reactivation of existing micro-organisms.
resistance	The capacity by an organism to remain unaffected by toxins or pathogenic micro-organisms.
respiratory	Pertaining to the lungs and the breathing apparatus of the body.
rodenticide	A chemical used to kill rodents.
roundworm	A group of parasitic nematode worms including <i>Ascans</i> and <i>Strongyloides</i> .
runoff	Precipitation which flows over the surface of the land as opposed to that which penetrates beneath the surface.
Salmonella	Bacteria that cause typhoid, diarrhoea and other diseases. It is usually associated with poultry and animal husbandry and transmitted from animal to humans and from humans to humans by the faecal-oral route and contamination of food and drinking water.
sandfly	A common name for flies of the group phlebotomine including the genus <i>Phlebotomus</i> . Sometimes vectors of leishmaniasis.
scabies	A contagious disease caused by the mite <i>Sarcoptes scabiei</i> which burrows in the outer layers of skin. It is transmitted by skin contact.
<i>Schistosoma haematobium</i>	A species of <i>Schistosoma</i> found chiefly in Africa and the Middle East. Affects the bladder and pelvic organs causing painful, frequent and bloody urination.
<i>Schistosoma japonicum</i>	A species of <i>Schistosoma</i> found in Japan, The Philippines and Eastern Asia. Causes gastrointestinal ulcerations and fibrosis of the liver.

<i>Schistosoma mansoni</i>	A species of Schistosoma which is found in Africa, the Middle East, the Caribbean and South America. Causes symptoms similar to <i>Schistosoma japonicum</i> .
schistosomiasis	A disease, caused by infestation of the human body by the trematode worms of <i>Schistosoma</i> , characterised by the passing of blood in the urine or stool. Also called bilharzia.
scoping	A process of defining which communities, hazards, geographical areas and project phases to include in an impact assessment.
screening	A process of sorting project proposals as part of an initial environmental examination to ascertain the need for health impact assessment.
scrub typhus	Mite-borne typhus fever.
seasonality	Showing periodicity related to seasons.
sedentarization	The settlement of nomads in permanent locations.
septicaemia	Systemic infection in which pathogenic micro-organisms are present in the blood stream.
septic fringe	The unsanitary environment of slums and squatters,
seropositive	A positive reaction in a blood test.
sewage	Human excreta and wastewater flushed along a sewer pipe.
<i>Shigella</i>	A genus of pathogenic bacteria that causes gastro-enteritis and bacterial dysentery. See dysentery.
silicosis	A chronic lung disease caused by long-term inhalation of silica dust.
<i>Simulium damnosum</i>	A species of biting fly that are vectors of onchocerciasis (river blindness). Found near fast flowing water. Common name is blackfly.
smallholder	A farmer who owns or rents a small area of farmland.
soakpit	A pit to promote seepage of effluent into the ground.
software	The rules by which hardware is effectively managed.
spillway	A structure for the discharge of overflow water.
standpipe	A tap on the end of a free standing water pipe.
steppe	A dry, grassy, generally treeless and uncultivated plain.
<i>Strongyloides</i>	A genus of parasitic intestinal nematode or roundworm.
subsistence	Providing the bare necessities of living.
sullage	Domestic dirty water not containing excreta; also called grey water.
surveillance	A continuing scrutiny of all aspects of the occurrence and spread of a disease that are pertinent to effective control. Alternatively, a special reporting system for a particular health problem for a limited time period,
susceptibility	The incapacity to resist contracting a disease when exposed to the agent causing that disease.
sustainability	The extent to which the objectives of an aid activity will continue after the project assistance is over', the extent to which the groups affected by the aid want to take charge themselves to continue accomplishing its objectives.
syndrome	A characteristic pattern of symptoms and signs that describe a disease entity
synergistic	Pertaining to a combined or co-ordinated action in which the effect of a substance or an organ is augmented by the use with another.
taeniasis	An infection with a tapeworm of the genus <i>Taenia</i> .
tailings	Soil and other debris washed out of a mine works.
tannin	A chemical used in tanning and dying,
tapeworm	A parasitic, intestinal worm that infects humans and animals.
tenosynovitis	A painful disorder of a muscle tendon often related to long-term exposure to repetitive motion, vibration, or inappropriate posture.
teratogenicity	Refers to the ability to cause interference with normal prenatal development in the foetus.
tilapia	A group of edible freshwater fish.

‘ t o p - d o w n ’	Refers to a theory in development in which improvements and incentives are envisaged to percolate through society and economy from the top level to the broad based lower levels.
toxoplasmosis	A common infection with the protozoan <i>Toxoplasma gondii</i> , an intracellular parasite of cats and other hosts which is transmitted to humans by ingestion or transplacentally from mother to foetus.
transmission	Any route by which a human being is exposed to an infectious agent.
trematodes	Flat worms including the parasitic worms called flukes e.g. clonorchiasis, fasciolopsiasis.
trichinosis	A disease caused by the migration through the skin of larvae of a worm called <i>Trichinella spiralis</i> .
<i>Trichuris</i>	A parasitic worm that infests the intestines of humans.
trypanosomiasis	A disease of animals and humans caused by a <i>Trypanosoma</i> parasite; called sleeping sickness in Africa and Chagas disease in South America.
tsetse	A blood-sucking fly that is the vector of trypanosomiasis in Africa.
tuberculosis	A chronic and disabling disease of the lungs, and less frequently other parts of the body, which is fatal if not treated.
tungsten	Wolfram. A rare metal.
typhoid	An infectious disease in humans caused by <i>Salmonella typhi</i> bacteria. It is transmitted by the faeco-oral route and contamination of drinking water and food.
typhus	An infectious disease spread from person to person by the body louse, fleas, mites or ticks. Caused by micro-organisms of the genus <i>Rickettsia</i> .
vector	An animal - often an insect - transmitting an infection from person to person or from infected animals.
virus	A very small parasitic organism which can only reproduce inside the animal or plant cells of a host, but can survive elsewhere.
<i>Vivax</i> malaria	A form of malaria caused by <i>Plasmodium vivax</i> . It is the most common form of malaria and rarely fatal. See also: malaria.
vulnerability	The liability to be injured or damaged or hurt.
watershed	A ground area (usually elevated) either side of which rainfall flows into different river systems. In the US the term is used to denote a rainfall catchment area for a river system.
whipworm	Common name for the parasitic roundworm <i>Trichuris trichiura</i> . Infects the intestinal tract. Indirectly transmitted from human to human through soil.
wild food	Food which is gathered, fished, or hunted, but not cultivated.
yellow fever	An acute arbovirus infection transmitted by mosquitoes for which there is no treatment.
zoonosis	An infectious disease transmissible under natural conditions from animals to humans.
zooprophyllaxis	The use of animals to divert vectors from humans

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