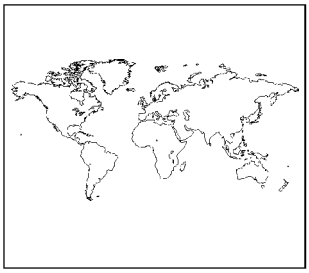


Health and peri-urban natural resource production

Martin H. Birley and Karen Lock

SUMMARY: *There is a growing interest in expanding crop, livestock and other forms of natural resource production in peri-urban areas. In part this is to capitalize on the availability of urban wastes for recycling and to improve the management of such wastes but also because of the economic potential of such production for increasing livelihoods and for better meeting urban demands. This paper examines the health problems facing the enterprises and inhabitants of peri-urban areas, including the risks posed by malaria, heavy metals, the re-use of solid and liquid wastes, agro-chemicals, biomass fuels and food contamination. It also emphasizes how both research and assessment procedures are required to ensure that natural resource production in peri-urban areas also safeguards human health.*

Dr. Martin Birley manages the International Health Impact Assessment Group at the Liverpool School of Tropical Medicine. He is also a member of the WHO/PEEM steering committee and has acted as consultant to The World Bank, the UK Deparment for International Development (DfID), WHO, the UN Food and Agriculture Organization and the Asian Development Bank.

Karen Lock is at present a public health doctor at Stockport Health Authority and has worked on a wide range of environmental projects both in the UK and overseas.

***This paper is drawn from a longer study, funded by the UK government's Department for International Development of the United Kingdom: Birley, M.H. and K. Lock (1997),* A**

I. INTRODUCTION

MOST CITIES IN the South are expanding rapidly and provide large markets for natural products, which may be produced in peri-urban areas that are also sinks for the city's wastes. The peri-urban zone can be broadly characterized as a mosaic of different land uses inhabited by communities of different economic status, in a state of rapid change with a lack of infrastructure and a deteriorating environment. It is a transition zone that is entirely rural at one end and urban at the other and the focus of this paper is to examine the effects of natural resource development projects on the health of poor communities living in this transition area. A more precise definition of peri-urban will be left to others. The natural resources themselves may pose health hazards during production, processing, transportation and consumption but there are also many health benefits to the poor from these activities.

All interventions can have unexpected impacts, positive as well as negative. Such impacts can affect the environment and the community as well as human health. A development project that threatens human health may be judged unsustainable and not cost-effective. One step towards safeguarding health is to conduct rapid health impact assessments of new projects.[1] Good management is frequently concerned with identifying problems,

Review of the Health Impacts of Peri-urban Natural Resource Development, *Natural Resources International, Chatham. This long study is available from Dr. Birley at the address and e-mail below. The views expressed here are those of the authors. We would like to thank the numerous staff of both national and international organizations who spared time to answer our questionnaire and to meet with us. We also thank Dr. Chris Lewcock of NRI who managed this project and remained encouraging throughout.*

Address: Martin Birley, Liverpool School of Tropical Medicine, Pembroke Place, Liverpool L3 5QA, UK; tel: (44) 151 708 9393; email: mhb@liv.ac.uk

1. Birley, M.H. (1995), *The Health Impact Assessment of Development Projects*, HMSO, London, 241 pages.

2. Birley, M.H. and K. Lock (1997), *A Review of the Health Impacts of Peri-urban Natural Resource Development*, Natural Resources International, Chatham.

3. See Box 1.

assessing their importance and proposing solutions. In the case of health impact assessment, this consists of identifying health hazards, assessing health risks and proposing risk mitigation measures. The first step, identifying health hazards, can be accomplished by studying the kind of health problems that have arisen on similar projects in other places and at other times. A detailed review of peri-urban, natural resource-linked health issues was recently commissioned and this forms the basis of this paper.[2] The second step, assessment of health risk, can be achieved by sub-dividing the problem into three components, namely community, environmental and institutional risk factors. Each of these components divides further. For example, the assessment of community risk factors starts by identifying the stakeholders and their immunity, perception and behaviour.

The assessment can then rank each health risk as likely to increase, decrease or remain the same for each stakeholder group as a consequence of the planned development. Although crude, this ranking should be sufficient to trigger the third component of the management response. There are a wide range of possible methods for guarding health during the implementation and operation of development projects, ranging from societal to individual responses. They generally have in common the requirement for inter-sectoral collaboration at the design stage. Small changes to design, construction, operation or maintenance is often all that is required but these cannot be planned unless appropriate research is conducted and an inter-sectoral debate takes place.

A large number of studies have described urban health issues but little health research has focused on peri-urban natural resource production.[3] In our own review, health hazards are identified either from specific peri-urban research or, more often, by reference to urban and rural differences.

II. OVERVIEW

THE DEMAND FROM the city for fresh fruit, vegetables, meat or biomass fuels is insatiable. Much of this produce may come from peri-urban farms, limited by the distance that produce can be transported to market. Production requires access to land, water and agro-chemicals. It often re-uses waste materials as input but also produces its own waste streams, especially during post-harvest processing.

Competition for freshwater is especially strong. Freshwater can be used for both domestic supply and irrigation but piped water is often unavailable. Freshwater sources include shallow and deep wells, surface water, water tankers and street vendors. Competition depresses groundwater levels, while street vendors may charge high prices. Pathogens transported down boreholes pollute groundwater and inorganic chemicals are transported through soils. Surface water is polluted by domestic and industrial discharges as well as by people who are washing, bathing, defecating and urinating. Latrines are often poorly

Box 1: Recent Works on Health in Urban Areas

Atkinson, S.J. and A. Merkle (editors) (1993), *Urban Health in Africa*, IIED, London, 71 pages.

Bradley, D., C. Stephens, T. Harpham, and S. Cairncross (1992), *A Review of Environmental Health Impacts in Developing Country Cities*, Discussion Paper 6, The World Bank, Washington DC, 58 pages.

Brantly, E., R. Hetes, B. Levy, P. Clydette, L. Whiteford, and M. Yacoob (1997), "Comparative health risk assessment: a method for setting priorities in environmental health" in Shahi, G., B. Levy, A. Binger, T. Kjellstrom, and R. Lawrence (editors) (1997), *International Perspectives on Environment, Development and Health, Towards A Sustainable World*, Springer, New York, pages 388-409.

Environmental Health Project (1996), "Health and the environment in urban poor areas: avoiding a crisis through prevention" in Environmental Health Project Capsule Report 1996, Environmental Health Project (USAID), Washington DC, pages 1-8.

Fluty, H. and J. Lissfelt (1995), "USAID's experience in urban health and directions for the future" in Harpham, T. and M. Tanner (editors) (1995), *Urban Health in Developing Countries, Progress and Priorities*, Earthscan, London, pages 153-171.

Goldstein, G., A. Rossi-Espagnet, and I. Tabibzadeh (1995), "How the World Health Organization supports urban health development" in Harpham, T. and M. Tanner (editors) (1995), *Urban Health in Developing Countries, Progress and Priorities*, Earthscan, London, pages 110-122.

Hardoy, J.E. and D. Satterthwaite (1997), "Health and environment and the urban poor" in Shahi, G., B. Levy, A. Binger, T. Kjellstrom, and R. Lawrence (editors) (1997), *International Perspectives on Environment, Development and Health, Towards A Sustainable World*, Springer, New York, pages 123-162.

Harpham, T. and M. Tanner (editors) (1995), *Urban Health in Developing Countries, Progress and Priorities*, Earthscan, London, 228 pages.

Listorti, J.A. (1996), *Bridging Environmental Health Gaps*, The World Bank, Washington DC.

Satterthwaite, D. (1993), "The impact on health of urban environments", *Environment and Urbanization* Vol.5, No.2, pages 87-111.

Songsore, J. and G. McGranahan (1993), "Environment, wealth and health: towards an analysis of intra-urban differentials within the Greater Accra Metropolitan Area, Ghana", *Environment and Urbanization* Vol.5, No.2, pages 10-34.

Stephens, C. and T. Harpham (1992), "Health and environment in urban areas of developing countries", *Third World Planning Review* Vol.14, No.3, pages 267-282.

World Health Organization (1997), *Health and Environment in Sustainable Development: Five Years After the Earth Summit*, World Health Organization, Geneva.

Yacoob, M. and M. Kelly (1997), "Creating sustainable environmental health conditions by redefining municipal roles and responsibilities: experiences from Tunisia and Ecuador", *Natural Resources Forum* Vol.21, No.1, pages 39-50.

sited and designed, over-used, overflowing, under-maintained or non-existent. Open defecation on shaded land and by riverbanks is commonplace.

The peri-urban environment receives waste from organized collections in the city, in the form of landfill sites, refuse mountains and polluted rivers. Both indoor and outdoor air pollution is present as a consequence of road transport, energy production, industrial activity and cooking.

People often change their work patterns as they migrate to the city: paid work more frequently takes place away from home, for both adults and children; the cost of commuting limits the separation of living and working zones; less time is available for caring and nurturing. Food consumption patterns change: babies are weaned earlier; food is cooked less frequently, stored longer or purchased from street vendors.

There are links between all categories of health issues and natural resource use. Some of the most evident linkages are listed in Figure 1 and are described in more detail in the longer report on which this paper is based. They include malaria and agriculture, solid waste and wastewater re-use, pathogens and heavy metal poisoning, agro-chemical poisoning, biomass fuels, and respiratory disease and malnutrition. Psycho-social disorders tend to cut across all other issues and are discussed below.

III. RURAL-URBAN TRANSITIONS

THE HEALTH ISSUES of the rural to urban transition include communicable disease (e.g. malaria), non-communicable disease (e.g. poisoning), injury, malnutrition and psycho-social disorders. These can be divided into traditional and modern diseases. The traditional diseases are mostly communicable or associated with under-nutrition, and are mostly immediate and localized. The modern diseases are mostly non-communicable or associated with injury, over-nutrition or psycho-social disorders. They are mostly delayed in onset and with multi-factorial causes. The change in the prevalence rate of these diseases with economic development has been referred to as the health risk transition.[4]

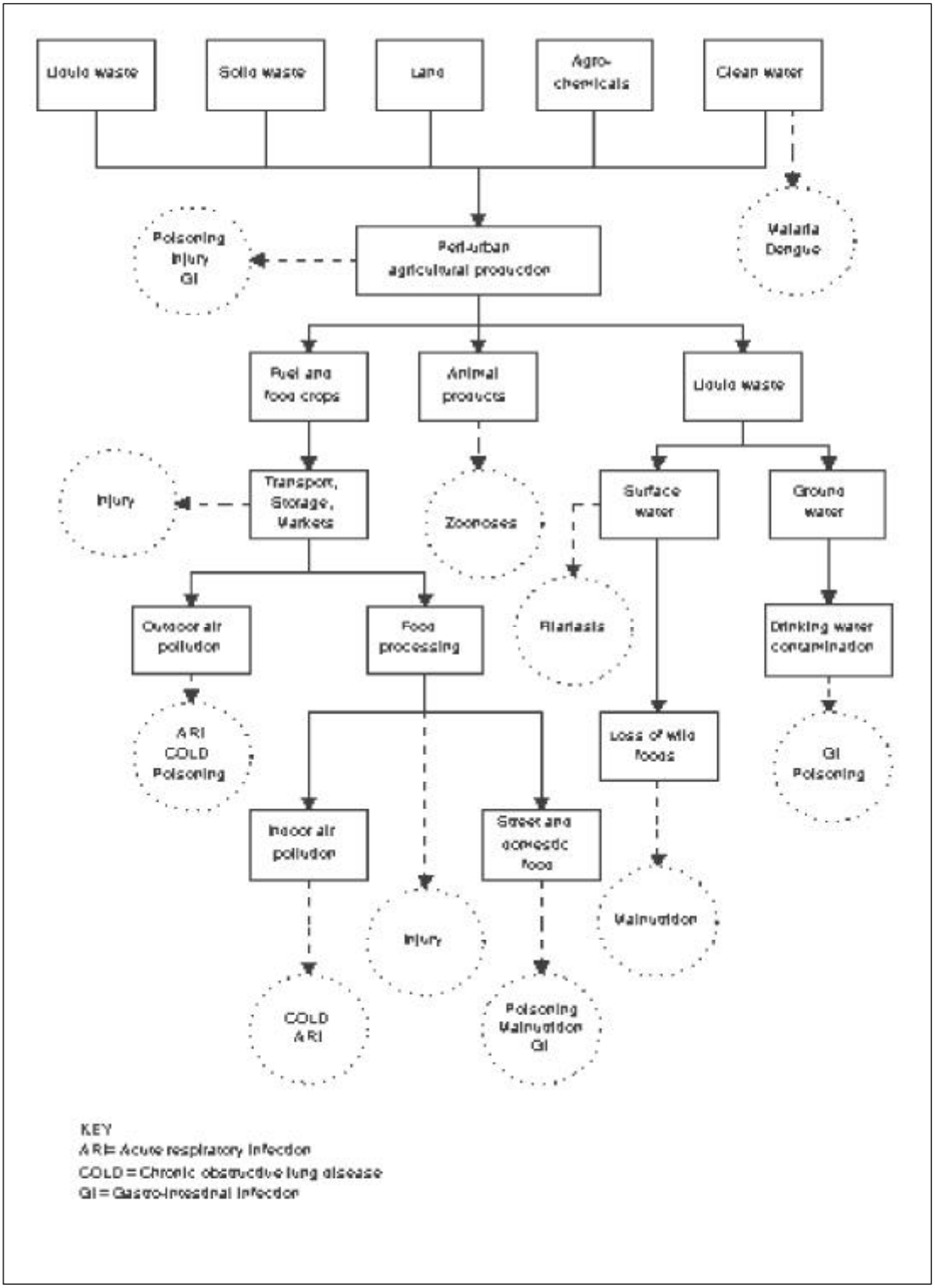
The health risk transition can be compared between regions, countries and cities as well as between rural to urban zones. The transition is clearest at the regional level. Figure 2 illustrates the changing contribution to morbidity of communicable disease, non-communicable disease and injury in different regions, measured in disability adjusted life years.[5] Recent comparisons of mortality between the cities of Accra, in Ghana, and Sao Paulo, in Brazil, show a similar pattern to Figure 2 as an example of less and more developed cities.[6] Similar disease patterns were also apparent between different socio-environmental zones of Sao Paulo. There are also age related patterns in poor urban areas: the urban poor must first survive the unsanitary insults of childhood, associated with diarrhoea and other communicable disease, and then the psycho-social effects of

4. Smith, K.R. (1997), "Development, health and the environmental risk transition" in Shahi, G., B. Levy, A. Binger, T. Kjellstrom and R. Lawrence (editors) (1997), *International Perspectives on Environment, Development and Health, Towards A Sustainable World*, Springer, New York, pages 51-62.

5. World Bank (1993), *World Development Report 1993*, Oxford University Press, New York, 329 pages.

6. Stephens, C., I. Timaeus, M. Akerman, S. Avle, P. Borlina Maia, P. Campanario, B. Doe, L. Lush, D. Tetteh and T. Harpham (1994), *Environment and Health in Developing Countries: An Analysis of Intra-urban Differentials Using Existing Data*, London School of Hygiene and Tropical Medicine, London and Fundacao SEADE, Sao Paulo, Brazil; also McGranaham, G., J. Songsore and M. Kjellen (1996), "Sustainability, poverty and urban environmental transitions" in Pugh, C. (editor) (1996), *Sustainability, the Environment and Urbanization*, Earthscan, London, pages 103-133.

Figure 1: Examples of health linkages with natural resource use

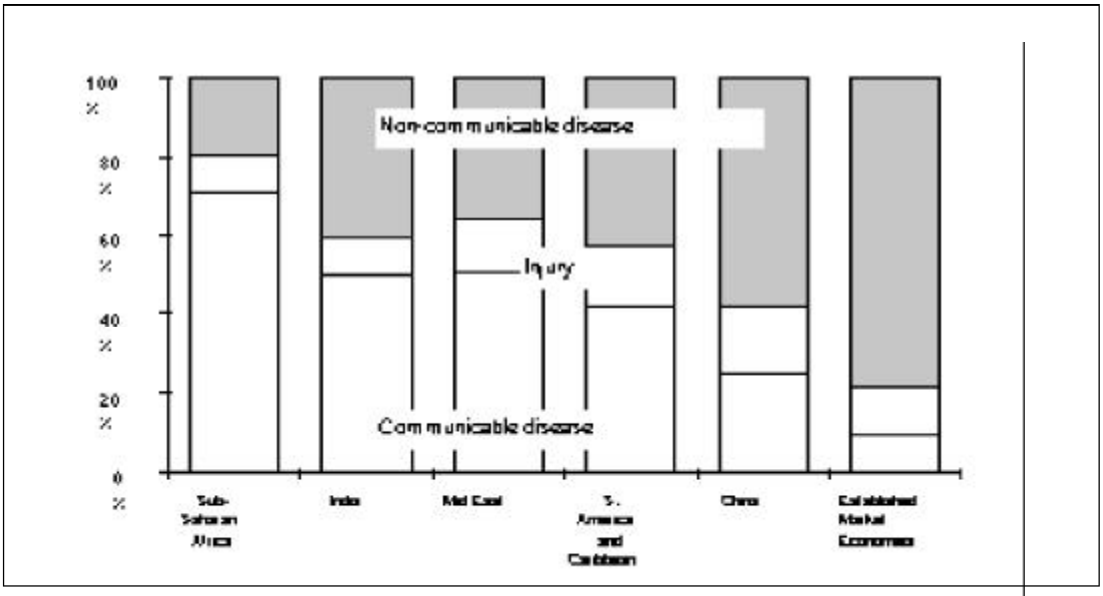


poverty in adulthood, associated with intentional injury and circulatory disease. There are similar contrasts in mortality between urban and rural communities in a single country, such as in Mexico.[7] For example, chronic lower respiratory diseases were more common in urban areas while acute lower respiratory and gastro-intestinal diseases were more common in rural areas. Infant mortality rates also showed marked differences between rural, low-income urban and other urban communities.[8] The low-income urban rates tended to be much higher.

7. See Harpham and Tanner (1993) in Box 1.

8. Black, M. (1996), *Thirsty Cities, Water Sanitation and the Urban Poor*, WaterAid, London.

Figure 2: Percentage Distribution of Disability-adjusted Life Years Lost to Non-communicable Disease, Communicable Disease and Injury by Region



These changes in disease patterns from traditional to modern are probably due to changes in the underlying risk factors.[9] Figure 3 is a testable model of the health risk transition for poor communities between rural, peri-urban and urban areas. The total risk may sometimes be highest in the peri-urban area: poor peri-urban communities may then live in the worst of both worlds.[10]

9. See Fluty and Lissfelt (1995) in Box 1.

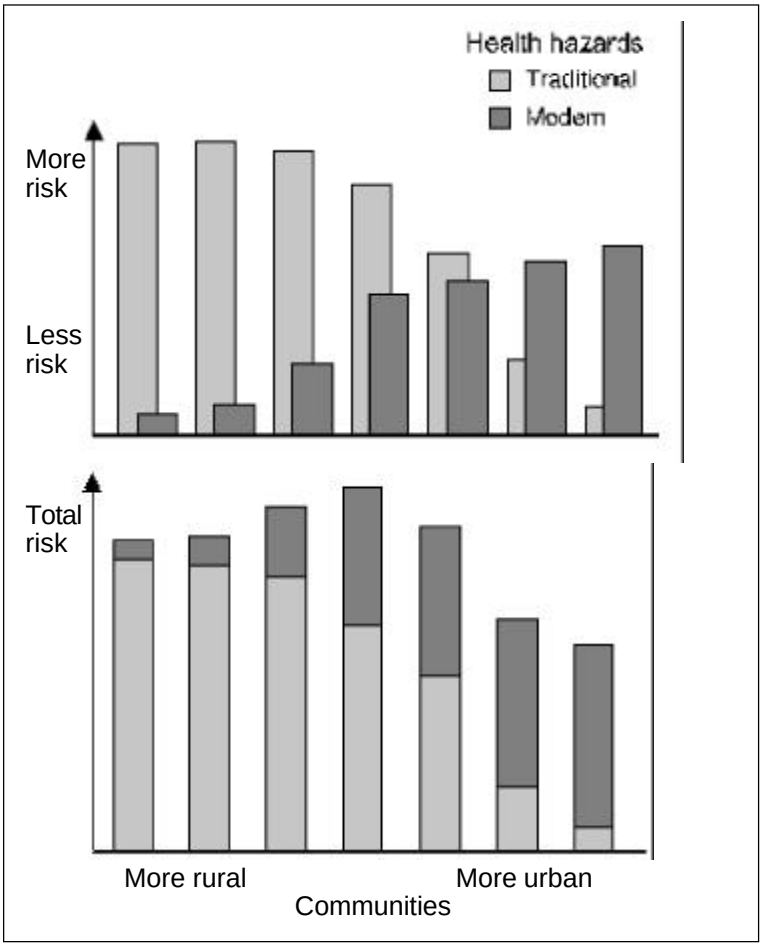
10. Ashton, J. (editor) (1992) *Healthy Cities,* Open University Press, Milton Keynes, 235 pages.

IV. MALARIA AND AGRICULTURE

MALARIA IS PRE-EMINENTLY an environmental disease as its transmission depends on the malaria mosquito. All environmental management, and modification and manipulation of tropical and sub-tropical environments, is likely to have either a positive or negative effect on mosquito reproduction, contact or survival. The direction of change in prevalence rates varies between ecosystems and requires careful analysis.

In 1996, one of the influential agencies associated with tropical disease research funding published a policy analysis of fu-

Figure 3: A Rural-Urban Health Transition Hypothesis



ture options for malaria research.[11] A striking feature of this report was an almost total absence of reference to the environment or to environmental causes of malaria transmission. The report places research emphasis elsewhere and thus illustrates the growing divide between the practical research needs of environmental institutions and the research interests of many health professionals. A number of agricultural research institutions have explicitly acknowledged health issues as being part of their sustainable development strategy, in part because of advocacy by PEEM, a joint UN agency committee of the World Health Organization, the Food and Agriculture Organization, the United Nations Environment Programme and UNCHS (Habitat). These institutions include members of the Consultative Group on International Agricultural Research. They also include the Natural Resources Systems Programme of the Department for International Development of the United Kingdom.

Urban agriculture provides an example of this need for research. Urban agriculture is being vigorously promoted, at present, through the activities of the urban agriculture network and elsewhere.[12] The urban agricultural movement has recognized some of the health hazards associated with urban and

11. Anderson, J., M. Maclean and C. Davies (1996), *Malaria Research: An Audit of International Activity*, Wellcome Trust Unit for Policy Research in Science and Medicine, London.

12. Smit, J., A. Ratta and J. Nasr (1996), *Urban Agriculture, Food, Jobs and Sustainable Cities*, United Nations Development Programme Publications Series for Habitat 2, Vol.1, United Nations Development Programme, New York.

13. See Atkinson and Merkle (1993) in Box 1; also Rossi-Espagnet, A., G. Goldstein and I. Tabibzadeh (1991), "Urbanisation and health in developing countries: a challenge of health for all", *World Health Statistics Quarterly* Vol.44, No.4, pages 187-244.

14. Lindsay, S.W., H. Campbell, J.H. Adiamah, A.M. Greenwood, J.E. Bangali and B.M. Greenwood (1990), "Malaria in a peri-urban area of The Gambia", *Annals of Tropical Medicine and Parasitology* Vol.84, pages 553-562; also Trape, J.-F., E. Lefebvre-Zante, F. Legros, G. Ndiaye, H. Bouganali, P. Druilhe and G. Salem (1992), "Vector density gradients and the epidemiology of urban malaria in Dakar, Senegal", *American Journal of Tropical Medicine and Hygiene* Vol.47, No.2, pages 181-189; Adiamah, J.H., K.A. Koram, M.C. Thomson, S.W. Lindsay, J.

peri-urban agricultural production. Malaria in Africa is one example where more careful consideration is necessary. There is a common but mistaken belief among local communities and decision makers that cereal crop production, such as maize, promotes malaria mosquitoes. Such mosquitoes do not breed in maize plants. They require sources of open and relatively unpolluted water. Malaria in Africa is largely a rural phenomenon. The frequency of illness and the abundance of malaria mosquitoes changes 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.[13] In particular, there are changes along the rural to urban transect.[14]. Box 2 provides an example. Promotion of urban agriculture may substantially increase the malaria risk by introducing new mosquito breeding sites but need not do so if appropriately designed.

Malaria in India is different to Africa, emphasizing the need for detailed local studies. There has always been urban transmission because the local vector breeds in artificial containers but the urban ratio is increasing.[15] A number of specific ecotypes have been identified. Industrial malaria is particularly relevant, as industrial complexes are frequently located in peri-urban areas, and it can be controlled by a judicious mix-

Box 2: Peri-urban Malaria in Brazzaville

In Brazzaville, the two main mosquito species are *An. gambiae*, the malaria vector, and *Cu. quinquefasciatus*, the nuisance mosquito. The main breeding sites colonized by malaria mosquitoes are in the small fertile valleys with clay soils, watered by streams and where vegetable crops are planted, and include riverbanks, adjacent hollows and the various installations used for watering crops. Because of their high agricultural value, these valleys had held out against urbanization. However, the low marshy banks of streams in poor soil zones had little agricultural value and had been rapidly urbanized. Malaria mosquitoes rarely used rainwater sites such as puddles, ditches and ruts. These sites were frequently polluted and were favoured by the nuisance mosquito.

Each new area of human settlement initially favoured the multiplication of breeding sites and high densities of malaria mosquitoes. Later, the canalization of surface water, domestic pollution and increased human densities tended to eliminate such breeding sites.

The following table summarizes the main results:

	Rural	Peri-urban	Urban
Malaria vector	-	37%	0%
Nuisance mosquito	-	63%	100%
Wet season *Anopheles* biting rate per night	>50	7	0
Malaria prevalence rate in children	75-90%	50-80%	<7%
Human population density	<50	150	200-250

SOURCE: Trape, J. - F. and A. Zoulani (1987), "Malaria and urbanization in Central Africa: the example of Brazzaville", *Transactions of the Royal Society of Tropical Medicine and Hygiene* Vol.81, Supplement No.2, pages 1-33.

Todd and B.M. Greenwood (1993), "Entomological risk factors for severe malaria in a peri-urban area of The Gambia", *Annals of Tropical Medicine and Parasitology* Vol.87, pages 491-500; and Lines, J., T. Harpham, C. Leake and C. Schofield (1994), "Trends, priorities and policy directions in the control of vector-borne diseases in urban environments", *Health Policy and Planning* Vol.9, No.2, pages 113-129.

15. Sharma, V.P. (1996), "Re-emergence of malaria in India", *Indian Journal of Malaria Research* Vol.103, pages 26-45.

16. Dua, V.K., S.K. Sharma, A. Srivastava and V.P. Sharma (1997), "Bioenvironmental control of industrial malaria at Bharat Heavy Electrical Ltd. Hardwar, India - results of a nine-year study (1987-95)", *Journal of the American Mosquito Control Association* Vol.13, No.3, pages 278-285.

17. See reference 12.

18. Hassan, I.A., M.R. Ashmore and J.N.B. Bell (1995), "Effect of ozone on radish and turnip under Egyptian field conditions", *Environmental Pollution* Vol.89, pages 107-114.

19. Mage, D.T. and O. Zali (editors) (1992), *Motor Vehicle Air Pollution, Public Health Impact and Control Measures*, WHO/PEP/92.4, World Health Organization, Geneva; also WHO (1995), *Human Exposure to Lead*, World Health Organization, Bangkok.

20. Alloway, B.J. (editor) (1995), *Heavy Metals in Soils,* Blackie Academic and Professional (second edition), London, 368 pages.

21. See reference 19, WHO (1995)

22. See reference 12.

23. See reference 19, WHO (1995).

24. UNEP (1992), *The Contamiture of biological and environmental methods, which is far more satisfactory than chemical control.*[16]

Other vector-borne diseases associated with urban and peri-urban areas include filariasis and dengue. The breeding sites of the vectors are strongly dependent on solid and/or liquid waste disposal systems.

V. HEAVY METAL POISONING

CONTAMINATION OF CROPS with heavy metals could lead to chronic poisoning of consumers.[17] The extent of the problem and the validity of solutions proposed are unclear and require further research.

Contamination of plants with heavy metals may occur through the air as well as from the soil and irrigation waters. Many major roads intersect peri-urban areas and air-borne deposition of heavy metals is frequently associated with road traffic and can substantially affect plant yield.[18]. A number of hazardous pollutants are associated with road traffic but it is unclear whether respiration or ingestion is the most important exposure pathway.[19] Lead is a cumulative poison and has been widely monitored. Lead particles from aerosols, for example, do not penetrate plant surfaces and such contamination can be substantially reduced by washing.[20] Other formulations containing lead may behave differently. A Chinese study concluded that lead ingestion through food was far more important than through inhalation. In the study area, a high percentage of children in (presumed) peri-urban villages had elevated blood levels and clinical symptoms of lead poisoning, compared to urban children. The source of lead was unclear. A study of bus drivers in Bangkok also observed that most lead absorption was from food, probably purchased from street vendors and kept uncovered.[21] It has been suggested that a boundary crop should be planted beside roads to protect crops from vehicle pollution.[22] But some studies found little associated lead contamination of roadside crops.[23]

Concentrations of lead are much higher in the liver and kidneys of animals and in crustacea and molluscs than in crops or milk.[24] 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.[25] There was a correlation with air, soil and dust levels. Studies in Nigeria found high levels of lead in the dust from unpaved roads. Other sources of contamination were edible fish from contaminated rivers and streams, and cooking salts from springs polluted by nearby mines. Ceramics using lead glazing are also an important source, especially in Mexico.

Much of the literature on plant uptake of heavy metals is concerned with deliberate extraction in order to decontaminate soil or aqueous streams.[26] This provides an example of non-food peri-urban agriculture being used to render soils and waters safe for food production.

nation of Food, United Nations Environment Programme, Nairobi.

25. Environmental Defense Fund (1994), *The Global Dimensions of Lead Poisoning: An Initial Analysis*, 1994, Alliance to End Childhood Lead Poisoning, Washington DC.

26. Nanda Kumar, P.B.A., V. Dushenkov, H. Motto and I. Raskin (1995), "Phytoextraction: the use of plants to remove heavy metals from soils", *Environmental Science and Technology* Vol.29, No.5, pages 1232-38; also Watanabe, M.E. (1997), "Phytoremediation on the brink of commercialization", *Environmental Science and Technology* Vol.31, No.4, pages 182A-186A; and Dushenkov, V., P.B.A. Nanda Kumar, H. Motto and I. Raskin (1995), "Rhizofiltration: the use of plants to remove heavy metals from aqueous streams", *Environmental Science and Technology* Vol.29, No.5, pages 1239-45.

27. JICA (1996), *Study on the Development of A Water Supply System for Damascus City. Phase 1*, Nippon Koei Co. and DAWASSA, Damascus.

28. Tarcher, A.B. (editor) (1992), *Principles and Practice of Environmental Medicine*, Plenum, New York.

29. Blevins, R.D. and L.A. Brennan (1990), "Fate of mutagenic activity during conventional treatment of municipal wastewater sludge", *Archives of Environmental Contamination and Toxicology* Vol.19, No.5, pages 657-664.

30. Chang, A.C., A. Page and T. Asano (1995), *Developing Human Health-related Chemical Guidelines for Reclaimed Wastewater and Sewage Sludge Applications in Agriculture*, World Health Organization, Geneva.

31. Mara, D. and S. Cairncross (1989), *Guidelines for the Safe Use of Wastewater and Excreta*

VI. INDUSTRIAL AND DOMESTIC WASTEWATER RE-USE

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 re-use projects. Wastewater used for irrigation may include industrial effluents, containing heavy metals, as well as domestic waste containing pathogens.

The risk posed by industrial contaminants will depend on their dilution and uptake pathways. The rivers flowing out of cities often receive mixtures of both domestic and industrial waste. Tanneries are natural resource-processing industries that are often found in peri-urban areas discharging substantial quantities of chromium salts into surface waters.[27] Chlorination of such effluent may change the salts from a less to a more toxic form.[28] However, some heavy metals precipitate in sludge and so concentrations in treated wastewater may be very small. Other mutagenic materials may be enhanced by activated sludge treatment. [29] Wastewater effluent is not usually destined to be drunk, however the chemicals may percolate into the groundwater, accumulate and be extracted in drinking water from wells. Some chemicals accumulate in soils.

Guidelines for limiting human exposure to hazardous chemicals in wastewater used in agriculture are at an early stage of development. 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 loading, it is necessary to determine intake through consumption of plants grown in contaminated soils. A tentative list of acceptable concentrations of various organic and inorganic compounds in soil is available but is regarded as a first approximation requiring further research.[30]

Liquid waste from domestic sewage is a valuable commodity in the peri-urban environment that can be used for irrigation, biogas production, and fertilizer for field crops and fishponds. However, the health hazards associated with such waste include many communicable diseases.

There has been considerable progress in the development of systems for safe wastewater production and use, culminating in publication of the WHO (Engelberg) Guidelines.[31] The guidelines relaxed standards for faecal bacteria but introduced new ones for nematode eggs. Recent studies have concluded that these standards are about right for protecting consumers providing that wastewater treatment systems are stable, secondary contamination with untreated wastewater does not occur and wild vegetables are not harvested and consumed by field workers.[32] The need for a series of barriers to infection was identified. These include crop type, method of irrigation and working practices. Crop types include food eaten raw, cooked food, tree crops and non-food crops. Untreated wastewater can be used to cultivate valuable ornamentals, seedlings and wood

crops provided that the workforce is protected. Methods of irrigation include field-flooding, localized irrigation and spraying. Together, these determine the degree of contamination of both the workforce and the produce. A number of issues remain unresolved.

Many parasites have a sufficiently long half-life to 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.

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 of the efficiency of disinfection procedures and that more research is needed.[33] Particular concern was expressed about decontamination procedures that use chlorination. 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. Viruses also accumulate in the sludge from waste treatment plants and proper drying and long-term storage was required to de-activate them, suggesting greater persistence than previously believed.

VII. SOLID WASTE RE-USE

INCREASED USE OF urban solid waste as a fertilizer requires policy changes and improved management.[34] Collection and disposal of refuse can consume up to 50 per cent of a municipal operating budget. In many cities, only 50-70 per cent of refuse is regularly collected. Where markets for solid waste exist there is usually a thriving trade which supports many destitute people who may live or work on refuse dumps that are often sited in peri-urban areas.[35] Many are abandoned children and destitute families. They may be exposed to extensive health risks, which are largely undocumented, and suffer exploitation and deprivation. 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 poisoning. Rates of intestinal worm infection, scabies and upper respiratory tract infection were higher amongst waste-picking versus non-waste-picking children in India.[36] These hazards are relatively under-researched compared to wastewater.[37] Water supply, for drinking and washing, and sanitation facilities are usually very poor at dump sites.

Composting organic waste for use as soil improver has the positive health benefit of sanitising by heat destruction of pathogens. However, this is only successful if high temperature composting is used or waste is stored for periods of about one year, and there is a risk of introducing unacceptable concentrations of heavy metals into the food chain.[38] Composted solid

in Agriculture and Aquaculture, World Health Organization, Geneva; also WHO (1989), *Health Guidelines for the Use of Wastewater in Agriculture and Aquaculture*, World Health Organization, Geneva.

32. Blumenthal, U.J., D.D. Mara, R.M. Ayres, E. Cifuentes, A. Peasey, R. Stott, D.L. Lee and G. Ruiz-Palacios, (1996), "Evaluation of the WHO nematode egg guidelines for restricted and unrestricted irrigation", *Water Science Technology* Vol.33, No.10-11, pages 277-283.

33. Schwartzbrod, L. (1995), *Effect of Human Viruses on Public Health Associated with the Use of Wastewater and Sewage Sludge in Agriculture and Aquaculture*, World Health Organization, Geneva.

34. Lewcock, C. (1995), "Farmer use of urban waste in Kano", *Habitat International* Vol.19, No.2, pages 225-234; also Schillhorn, T. and P.E. O'Connell (1997), "Urban waste and rural soil management" in *Agriculture Technology Notes, Agricultural and Forestry Systems Division, World Bank*, Washington DC.

35. Furedy, C. (1996), "Solid waste reuse and urban agriculture - dilemmas in developing countries: the bad news and the good news" in Association of Collegiate Schools of Planning and Association of European Schools of Planning, Joint International Congress, Myerson Polytechnic University, Toronto.

36. Hunt, C. (1996), "Child waste pickers in India: the occupation and its health risks", *Environment and Urbanization* Vol.8, No.2, pages 111-118.

37. See reference 35.

38. Jeevan Rao, K. and M.V. Shantaram (1995), "Contents of heavy metals in crops treated with urban solid wastes", *Journal of Environmental Biology* Vol.16, No.3, pages 225-232.

waste can also cause injury to farmers as sharp objects are not always properly removed.[39]

A South African study of household risk factors for diarrhoea in peri-urban areas identified not owning a refuse receptacle as a significant factor.[40] Houseflies are important in the transmission of enteric infections.[41] Disease transmission by houseflies is greatest where inadequate refuse storage, collection and disposal is accompanied by inadequate sanitation.

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.[42] Combustible gases will be generated from waste tips for more than 20 years and these travel under roads and through ducts to create an explosion hazard in buildings, as happened in Turkey.[43]

VIII. AGRO-CHEMICAL POISONING

a. Introduction

MORE THAN 1,000 chemical compounds, and biological and physical agents are used as insecticides, fungicides, herbicides, rodenticides, fertilizers and anti-microbials. They have been responsible for substantially increasing food production and also for controlling some important human diseases such as malaria and typhus. However, these agro-chemicals also cause a wide range of health problems varying from straightforward topical irritant reactions to complex systemic illnesses which can have both acute and chronic clinical effects.[44]

The variation in pesticide use along the rural-urban transition is a matter of debate. It has been suggested that small-scale urban farmers may use little.[45] A study from Lusaka observed a household usage rate of 23 per cent in rural areas, 64 per cent in peri-urban areas and 36 per cent in urban areas.[46] There were also gender specific differences. In horticulture, there are believed to be many opportunities for reducing the amount and frequency of spraying although it may be over-optimistic to suggest that use of pesticides can be entirely eliminated.

There are many potential exposure pathways, both occupational and non-occupational.[47] Some 3 million people annually suffer ill-health from single short-term exposure to pesticides. Approximately 1 million are serious unintentional poisonings and 2 million are suicide attempts.[48] Fatality rates vary from 1 per cent to 9 per cent and over 700,000 people a year suffer from the chronic effects of long-term exposure. The symptoms of pesticide poisoning may be incorrectly ascribed to other causes.

The acute clinical effects of pesticide poisoning are very varied. For example, organophosphates can cause diarrhoea, nau-

39. Nicolaisen, D., U. Plog, E. Spreen and S.B. Thapa (1988), *Solid Waste Management with People's Participation: An Example in Nepal*, GTZ, Eschborn, 82 pages; also Allison, M. and P. Harris (1996), *A Review of the Use of Urban Waste in Peri-urban Interface Production Systems*, The Henry Doubleday Research Association, Coventry.

40. See Atkinson and Merkle (editors) (1993) in Box 1.

41. Chavasse, D., N. Ahmad and T. Akhtar (1996), "Scope for fly control as a diarrhoea intervention in Pakistan: a community perspective", *Social Science and Medicine* Vol.43, No.8, pages 1289-1294.

42. WHO (1985), *Environmental Pollution Control in Relation to Development*, World Health Organization, Geneva.

43. Associated Press (1993), "Refuse kills 13", in *The Times,* London, page 15.

44. O'Malley, M. (1997), "Clinical evaluation of pesticide exposure and poisonings", *The Lancet* Vol.349, pages 1161-1166; also Forget, G., T. Goodman and A. de Villiers (editors) (1993), *Impact of Pesticide Use on Health in Developing Countries*, International Development Research Centre, Ottawa, 335 pages.

45. See reference 12, Smit, Ratta and Nasr (1996); also anonymous referee, *personal communication.*

46. Drescher, A.W. (1997), "Urban agriculture in the seasonal tropics of Central Southern Africa" in *Management Strategies in African Homegardens and the Need for New Extension Approaches*, City Farmer, Canada's Office of Urban Agriculture; see also the website: http://www.cityfarmer.org/AxelA.htm

47. WHO Commission on Health and Environment (1992), *Report of the Panel on Food and Agri-*

sea, 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.[49] Other pesticides can cause convulsions, cognitive impairment, liver and kidney impairment, lung fibrosis and coma.[50] Many older and more toxic pesticides are still available in stores and market places.

b. Occupational Agro-chemical Poisoning

Unintentional acute and chronic pesticide poisoning is an occupational hazard of agricultural workers.[51] The level of risk of exposure to chemicals is usually higher in intensive farming and horticulture than in traditional farming.[52] For example, there is evidence of increased adult male mortality among rural intensive rice cultivators in the Philippines which is attributed to chronic exposure.[53] A preliminary study on pesticide exposure among female floriculturalists in Bogota determined that large numbers of pesticides were being used and there were significant differences in foetal loss, prematurity and congenital malformation among women according to their exposure.[54]

Lack of knowledge and improper practices are the main causes of poisoning.[55] Low levels of literacy and education, and poor access to training increase the risk. Application is often by itinerant, unskilled, unsupervised operators. It is common to observe storing, mixing, application and disposal without adequate safety precautions. Protective clothing is expensive and hot. There is poor access to water and soap for decontamination. 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. Lack of knowledge of pesticide toxicity does not completely explain dangerous application practices.[56] Occupational exposure in pesticide factories and stores is often very intense and these facilities may frequently be located in peri-urban or urban areas.[57]

c. Non-occupational Agro-chemical Poisoning

Rare, unintentional mass-poisoning occurs when people consume treated grains or contaminated stored produce or use pesticide containers as cooking utensils, for water storage and collection. Empty containers are often sold in the markets. Chronic illness has also been associated with agro-chemicals in the food chain, including in red meat, poultry, vegetables and eggs.[58] 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.[59] The variation along the rural-urban transect is unknown.

Pesticide residues in locally grown vegetables are frequently far in excess of the acceptable limits. Green leafy vegetables are especially at risk.[60] Many species of wild food, including fish, molluscs, crustacea, insects and vegetables are harvested among cultivated crops that have been sprayed with chemicals. Such

culture, World Health Organization, Geneva.

48. WHO (1986), *Informal Consultation on Planning for the Prevention of Pesticide Poisoning*, World Health Organization, Geneva.

49. Rosenstock, L., M. Keifer and W. Daniell (1990), "Chronic central nervous system effects of acute organophosphate pesticide poisoning", *The Lancet* Vol.338, pages 223-227; also Amr, M.M., M. El Batanouni, A. Emara, N. Mansour, H.H. Zayat, G.A. Atta and A. Sanad (1993), "Health profile of workers exposed to pesticides in two large-scale formulating plants in Egypt" in Forget, G., T. Goodman and A. de Villiers (editors) (1993), *Impact of Pesticide Use on Health in Developing Countries*, International Development Research Centre, Ottawa, pages 118-130; and Stephens, R., A. Spurgeon and I.A. Calvert (1995), "Neuropsychological effects of long-term exposure to organophosphates in sheep dip", *The Lancet* Vol.345, pages 1135-1139.

50. See reference 44, O'Malley (1997).

51. See reference 49, Stephens, Spurgeon and Calvert (1995); also Loevinsohn, M.E. (1987), "Insecticide use and increased mortality in rural Central Luzon, Philippines", *The Lancet* Vol.332, No.8546, pages 1359-1362; McCracken, J.A. and G.R. Conway (1987), *Pesticide Hazards in the Third World: New Evidence From the Philippines*, International Institute for Environment and Development, London; and Pingali, P.L. and C. Marquez (1990), "Health costs of long-term pesticide exposure in the Philippines - a medical and economic analysis" in Annual General Meeting of the American Agricultural Economics Association, Social Science Division, International Rice Research Institute, Manila, Philippines.

52. See reference 47, WHO Com-

foods are especially important for the poor. Unacceptable concentrations are often found in drinking water.[61]

Urban and peri-urban communities often depend on groundwater sources that are readily contaminated with nitrogen that originates in fertilizers.[62] Excess nitrogen poses a health risk especially to bottle-fed babies. Increased use of urban solid waste as a fertilizing material in peri-urban areas may reduce this risk.[63]

IX. BIOMASS FUELS: RESPIRATORY DISEASES, INJURY AND MALNUTRITION

PROVISION OF ENERGY has many direct and indirect benefits to health. For example, electricity is used in the refrigeration of food and medical supplies, and fossil fuels are used in the manufacture of fertilizers. There are several major reviews of the negative health impacts of the energy sector.[64] Identified hazards include: indoor air pollution from biomass and fossil fuel combustion; exposure of urban and peri-urban populations to high levels of ambient air pollution; and serious injuries associated with extraction, storage and power generation. There is an energy transition, similar to the health transition, as people move from more rural to more urban environments and from less developed to more developed economies.[65] This is a transition from more traditional to more modern energy sources, also called an energy ladder. Cheaper fuels tend to be more polluting. As income increases people tend to move up the energy ladder. Fuel use can show seasonal variations and purchased fuel may be supplemented with gathered fuel. Households under energy stress employ a range of management strategies that affect their nutrition and food safety. Food vendors may extend their cooking times and hence their exposure to air pollutants. Working women may shorten their cooking times, producing undercooked foods that are less safe.

Urban and peri-urban poverty may reinforce exposure to pollution at the household level. The poor may have reduced access to less polluting technologies, pay more for fuel than the more wealthy and live in areas more affected by industrial or traffic pollution.[66] On the other hand, 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. Energy expenditure occupies a prominent place in poor households. For example, in Kenya, very low-income communities spent 30 per cent of their income on food and 10-30 per cent on fuel.[67] Energy collection, production and use is gender related. Household cooking on an open fire has been described as the largest single occupational health problem in the world for women.[68] Infants and young children are exposed to smoke for long periods. The smoke from biomass fuels tends to cause acute respiratory disease in children and chronic obstructive lung disease in adults while the smoke and heat may cause eye diseases.[69] Stoves are often at floor level causing injuries, especially burns to children, and jeopardizing food hygiene.[70]

mission on Health and Environment (1992).

53. See reference 51, Loevinsohn (1987) and Pingali and Marquez (1990).

54. Restrepo, M., et al. (1994), "Pesticides exposure and reproductive outcomes" in Sims, J. (editor) (1994), *Women, Health and Development, An Anthology*, World Health Organization, Geneva, pages 122-125.

55. See reference 44, Forget, Goodman and de Villiers (editors) (1993).

56. Yvon, J. (1997), *Farmers' Perceptions: Pests and Their Management for Tomato and Garden Egg Production*, Integrated Food Crop Systems Project, Natural Resources Institute, Chatham.

57. See reference 49, Amr et al. (1993).

58. See reference 44, Forget, Goodman and de Villiers (editors) (1993).

59. FAO and WHO (1988), "Guidelines for predicting the dietary intake of pesticide residues", *Bulletin of the World Health Organization* Vol.66, pages 429-434.

60. Conway, G.R. and J.N. Pretty (1991), *Unwelcome Harvest: Agriculture and Pollution*, Earthscan Publications, London.

61. See reference 47, WHO Commission on Health and Environment (1992).

62. Conway, G.R. and J.N. Pretty (1988), "Fertilizer risks in the developing countries", *Nature* Vol.334, No.6179, pages 207-208; also Environmental Health Project (1995), *Strategic Framework 1995-1999*, Environmental Health Project (USAID), Washington DC.

63. See reference 34, Lewcock (1995).

64. Cooper Weil, D.E.C., A.P. Alicbusan, J.F. Wilson, M.R. Reich and D.J. Bradley (1990), *the Impact of Development Policies on Health: A Review of the Literature*, World Health Organization, Geneva, 165 pages; also WHO (1992), *Epidemiological, Social and Technical Aspects of Indoor Air Pollution From Biomass Fuel*, World Health Organization, Geneva; and Smith, K.R. (1993), "Fuel combustion, air pollution exposure, and health: the situation in developing countries", *Annual Review of Energy and the Environment* Vol.18, pages 529-566.

65. ETSU (1996), *A Review of Energy Utilisation in Peri-urban Production Systems*, ETSU, Harwell.

66. Leitmann, J. (1991), *Energy-environment Linkages in the Urban Sector*, UNDP, New York.

67. See reference 65; also Harrison, P. (1987), *The Greening of Africa: Breaking Through in the Battle for Land and Food*, Paladin, London.

68. WHO Commission on Health and Environment (1992), *Report of the Panel on Energy*, World Health Organization, Geneva.

69. See reference 64, WHO (1992).

70. See Listorti (1996) in Box 1; also reference 68.

71. See reference 5.

72. See Listorti (1996) in Box 1.

73. See reference 66; also Dutt, D., D.K. Srinivasa, S.B. Rotti, A. Sahai and D. Konar (1996), "Effect of indoor air pollution on the respiratory system of women using different fuels", *National Medical Journal of India* Vol.9, No.3, pages 113-117.

74. See reference 64, Cooper Weil et al. (1990).

75. See reference 66.

Respiratory ailments are strongly associated with fuel use and energy efficiency. Fifty per cent of the burden of disease in poor countries has been attributed to indoor air pollution.[71] In the period 1984-94, some 1.3 per cent of spending in sub-Saharan Africa was devoted to improving efficiency of cooking stoves but it was done for ecological not health reasons.[72] Improved cooking stoves may reduce particulate concentrations and carbon monoxide by 50 per cent or more and improved lung function has been associated with a switch to less polluting fuels.[73] There is widespread agreement that a more integrated approach is required that considers improvements in kitchen conditions more generally. Fuelwood is one of the safest crops to grow with wastewater because it minimizes the danger of contamination by pathogens or hazardous chemicals.

An increasing percentage of women's available time may be spent on gathering fuel because of increasing scarcity. Fuelwood often has to be transported long distances on heads and backs, promoting occupational injury. A study in India suggested that the energy cost of collecting fuelwood and water, and of other domestic chores represented one-third of a woman's daily energy expenditure.[74] 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. This degradation casts an "urban shadow" over the peri-urban areas, especially along transportation routes.[75]

In addition to domestic air pollution, relatively little research has been done on the occupational health and safety of workers in cottage industries and institutions that use biomass fuels. These include brickmakers, ceramic factories, schools and hospitals.

X. MALNUTRITION, FOOD SECURITY AND FOOD SAFETY

MUCH NATURAL RESOURCE development is concerned with food production, processing, delivery and consumption. The main health problems are food contamination and lack of food.

A process of nutritional transition is associated with the rural-urban transition.[76] At its simplest, this consists of a change from undernutrition to overnutrition. Urban diets are considered to differ broadly from rural diets by showing trends towards the following: more "superior grains" such as rice and wheat rather than corn or millet; more milled and polished grains; food with higher fat contents; more animal products and sugar; food prepared away from home; and more processed food. Average infant and child mortality rates and childhood malnutrition rates appear to be lower in urban than in rural communities.[77] Some evidence suggests that urban diets are more diverse and the amount of both energy and micro-nutrients is greater in urban diets than in rural diets. On the other hand, the diets of the urban and peri-urban poor may sometimes be worse than their rural counterparts as intra-urban differentials

are very great. Rates of malnutrition are much higher in poorer areas and the differences between poor and wealthy areas are greater than urban-rural differences.[78] For example, urban slum communities in Thailand were more undernourished than rural communities.

Food security is one determinant of malnutrition and it is a complex problem dependent on factors such as food quality, quantity, regularity, affordability and with rural, peri-urban and urban components.[79] The price and availability of food often depends on urban purchasing patterns, distribution systems and transport. Wholesale markets are often run-down, too small and badly managed. Small and scattered retail markets cater to the needs of the urban and peri-urban poor who must make frequent purchases of tiny amounts.

Diarrhoea is still the major cause of morbidity and mortality in children and food contamination is an important cause.[80] Some food-borne pathogens, such as *Listeria* and *Toxoplasma*, are dangerous during pregnancy as infection of the foetus can cause death or serious malformations. Undernourished children are more susceptible to communicable disease and are more likely to die than the better nourished.[81] The effects of undernutrition include less than average weight or height, blindness, cretinism, anaemia, bone diseases and poor skin condition. Women and children are especially vulnerable because of differential entitlements that occur within the household.

One cause of childhood malnutrition is believed to be inadequate maternal care such as breast-feeding, food preparation and hygiene. Infants that were breast-fed for less than six months in Latin America had a greatly increased risk of dying. Working mothers often have to rely on artificial feeding provided by other child carers and reduced breast-feeding seems to be a feature of urbanization; opportunities for breast-feeding infants in the urban workplace are limited.

In some countries, 25 per cent of urban household budgets is spent on street foods.[82] 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 suggested that it was no less nutritious than modern commercial food and 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.[83]

Food preparation and storage in poor domestic environments provides many opportunities for contamination.[84] For example, peri-urban migrants in Lima, Peru, prepared their food in the morning, ate some at lunch and kept the rest until supper when it was reheated.[85] Infants in these households had diarrhoea and contamination of food by faecal matter was observed. Thermoses and containers for babies' milk were not properly sterilized and baby foods were kept too long after opening or preparation. Domestic animals had access to food preparation areas. Reheating procedures were relatively ineffective. Use of refrigerators was poor or they were unavailable. A study in Liberia noted higher rates of *Campylobacter* in urban versus ru-

76. Popkin, B.M. (1996), "Understanding the nutrition transition", *Urbanisation and Health Newsletter* Vol.30, September, pages 3-19.

77. IFPRI (1996), *Urban Challenges to Nutrition Security: A Review of Food Security, Health and Care in the Cities*, International Food Policy Research Institute, Washington DC.

78. See reference 13, Rossi-Espagnet, Goldstein and Tabibzadeh (1991); see also reference 77.

79. See reference 76; also Hutabarat, L.S.R. (1994), *Street Foods in Bangkok, the Nutritional Contribution and the Contaminants Content of Street Foods*, Food and Agriculture Organization, Rome; FAO (1995), *Street Foods*, Food and Agriculture Organization, Calcutta; and Ngleshie-Amanfro Study Team (1996), *Ngleshie-Amanfro: A Participatory Rapid Appraisal of Food Security in a Peri-urban Community*, Noguchi Memorial Institute for Medical Research, Centre for Community Studies, Action and Development, May Day Rural Project, International Food Policy Research Institute.

80. See reference 47, WHO Commission on Health and Environment (1992).

81. See reference 13, Rossi-Espagnet, Goldstein and Tabibzadeh (1991).

82. See reference 77.

83. See Atkinson and Merkle (editors) (1993) in Box 1.

84. Bryan, F.L. (1992), *Hazard Analysis Critical Control Point Evaluations, A Guide to Identifying Hazards and Assessing Risks Associated with Food Preparation and Storage*, World Health Organisation, Geneva; also Motarjemi, Y., F. Kaferstein, G. Moy, K. Miyagishima, S. Miyagawa and A. Reilly (1995), *Food Technologies and Public*

Health, World Health Organization, Geneva; and WHO (1996), *Guidelines for Strengthening A National Food Safety Programme*, World Health Organization, Geneva.

85. Bryan, F.L., S. Michanie, N.M. Fernandez, M.M. Vizcarra, D. Taboada, O. Navarro S., A.B. Alonso and E.G. Requejo (1988), "Hazard analyses of foods prepared by migrants living in a new settlement at the outskirts of Lima, Peru", *Journal of Food Protection* Vol.51, pages 323.

86. See Atkinson and Merkle (editors) (1993) in Box 1; also World Resources Institute (1996), *World Resources 1996-97*, Oxford University Press, Oxford and New York.

87. Hendrickse, R.G. (1991), "Clinical implications of food contaminated by aflatoxins", *Ann Acad of Med (Singapore)* Vol.20, No.1, pages 84-90.

88. World Health Organization (1997), "Multi-drug resistant *Salmonella typhimurium*", *WHO Factsheet* Vol.139, page 4.

89. World Health Organization, *personal communication.*

90. See reference 6, Stephens et al. (1994) and McGranaham, Songsore and Kjellen (1996); also Guerrero, R. (1996), "Cali: the right priorities", *World Health* Vol.49, No.1, page 10.

91. See reference 5, World Bank (1993).

92. Harpham, T. and I. Blue (editors) (1995), *Urbanisation and Mental Health in Developing Countries*, Avebury, Aldershot, 266 pages; also Blue, I. and T. Harpham (1996), "Mental health matters", *World Health* Vol.49, No.1, pages 34-35; and Reichenheim, M. and T. Harpham (1991), "Maternal mental health in a squatter settlement of Rio de Janeiro", *British Journal of Psychiatry* Vol.155, pages 44-47.

ral children. The water quality was better in urban areas but 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.[86]

Stored food products are susceptible to contamination by mycotoxins such as aflatoxin. The many adverse effects can include reduced effectiveness of immunization programmes, increased susceptibility to communicable diseases such as measles, malaria and HIV, acute fatal poisoning and long-term risks of liver cancer.[87] Aflatoxins cross the placenta and are excreted in the milk of both women and domestic animals. Infants are often exposed to it. Street sellers may obtain their raw materials from a range of uncontrolled sources and these may often be low grade and contaminated.

Use of contaminated animal faeces, for example from intensively reared poultry, may spread drug-resistant pathogens through the food chain.[88] Widespread use of antibiotics in aquaculture may also lead to antibiotic resistance in human pathogens when people eat products that contain high residues although there are no studies confirming this. Little is known about post-harvest decontamination of vegetable crops grown using solid or liquid waste and a review is under preparation.[89]

XI. PSYCHO-SOCIAL DISORDERS

MENTAL AND PSYCHO-SOCIAL disorders have only recently started to receive concerted research attention in relation to urbanization. Mental disorders grow as a component of modern diseases in the health transition.[90] A substantial burden of non-communicable disease has been attributed to this source.[91] Rates are about twice as high in women because they are often victims of violent or alcoholic family members. The economic cost is unknown but it contributes significantly to lost productivity, hospitalization and early retirement. Intentional injury was identified as an important component of mortality in Sao Paulo.

A model of mental disorder recognizes a set of stressors, or risk factors, including the following, relating to the peri-urban/urban environment:[92]

- poor physical environment, including lack of open space, overcrowding and noise;
- switch from subsistence to cash-cropping;
- insecure tenure;
- women's participation in the labour force;
- underemployment;
- 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.

The evidence is mixed regarding differentials between rural

and urban environments; there are many confounding factors. An important set of risk factors includes life stresses combined with the corresponding 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. Others may suffer considerably from more subtle manifestations of disorder. There are also cultural aspects to the expression and resolution of emotion.

XII. CONCLUSION

THERE ARE MANY more health issues associated with peri-urban natural resource development than those illustrated above, for example zoonoses and dust induced lung diseases. These are described in the main report.[93] Consequently, there are many areas where joint research between natural resource specialists and health specialists is required. But such research is of little consequence unless it is translated into action. One area where this is possible is the prospective analysis of the health impacts of proposed development projects. Once the risk is identified there are often many opportunities for mitigation.

93. See reference 2.