Abbreviations

ADPS	Aerial (sometimes "Airborne") Digital Photographic System
AGI	Association of Ghanaian Industries
AIS	Airborne Information System
APR	Annual Percentage Rate
CBO	Community based organisation
CEC	Cation exchange capacity
CEDAR	Centre for Developing Areas Research
CIRAD	Centre de Coopération Internationale en Recherche Agronomique pour le Développement
DAP	Diammonium phosphate
DEM	Digital Elevation Model
DFID	Department for International Development
DIC	District Industrial Centre
DZP	Dharwad Zilla Panchayat
EU	European Union
FAO	Food and Agriculture Organisation of the United Nations
GATT	General Agreement on Tariffs and Trade
GIS	Geographical Information System
GKCR	Greater Kumasi city region
GLCM	Grey level Co-occurrence
GNP	Gross National Product
GOAN	Ghana Organic Agriculture Network
GPS	Geographical Positioning System
HDMC	Hubli-Dharwad Municipal Corporation
HDUDA	Hubli-Dharwad Urban Development Authority
HRV	High Resolution Videography
IAI	Intelligent Aerial Interpolation
IATF	Inter-Agency Task Force
IRNR	Institute of Renewable Natural Resources
KCC	Kumasi City Council
KFC	Kentucky Fied chicken
KMA	Kumasi Metropolitan Assembly
KMF	Karnataka Milk Federation
KNRM	Kumasi Natural Resources Management
KNRMP	Kumasi Natural Resources Management Project

KSRSTUC	Karnataka State Remote Sensing Technology Utilisation Centre
KUMINFO	Kumasi Information GIS
KUPGIS	Kumasi Geographic Information System
LPG	Liquefied Petroleum Gas
MMPO	Milk and Milk Products Order
MOFA	Ministry of Food and Agriculture (Ghana)
MSW	Municipal Sewage Waste
NADMO	National Disaster Management Organisation
NGO	Non-governmental Organisation
NPK	Compound fertiliser containing N,P & K
NR	Natural Resources
NRDMS	Natural Resource Data Management Service (Karnataka District)
NRI	Natural Resources Institute
NRSP	Natural Resources System Programme
NS	Night Soil
OM	Organic matter
PC	Pit Compost
PRA	Participatory Rural Appraisal
PUDSI	Peri-urban Demonstrator for Spatial Data Integration (GIS)
PUI	Peri-urban Interface
RNRRS	Renewable Natural Resource Research Strategy
RRA	Rapid Rural Appraisal
SAM	Social Analytical Model
UNCHS	United Nations Centre for Human Settlements
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Education, Science and Cultural Organisation
UST	University of Science and Technology, Kumasi
USW	Urban Solid Waste
VAT	Value Added Tax
VCS	Village characterisation study
WTO	World Trade Organisation

1 Introduction

Background

More than half the world's population lives in areas that are classified as urban. In developing countries, a substantial and growing proportion lives in or around metropolitan areas and large cities, including the zone termed the 'peri-urban interface', where their livelihoods depend to some extent on natural resources such as land for food, water and fuel, and space for living.

The population pressure means that resources in such zones are often over-exploited. Although heterogeneous in its social composition, the peri-urban interface (PUI) constitutes the habitat of a diversity of populations, including lower income groups who are particularly vulnerable to the impacts and negative externalities of both rural and urban systems. This includes risks to health and life and physical hazards related to the occupation of unsuitable sites, lack of access to clean water and basic sanitation and poor housing conditions. Environmental changes also impinge upon the livelihood strategies of these communities by decreasing or increasing their access to different types of capital assets (including access to natural resources such as land, water, energy).

The UK Department for International Development (DFID) conducts its natural resources research programme mainly though programmes coming under the Renewable Natural Resource Research Strategy (RNRRS). RNRRS comprises a number of programmes, of which the Natural Resource Systems Programme (NRSP) is one. Each programme has to address particular production systems, and this volume is concerned with the Peri-Urban Interface (PUI) system.

In 1996, the NRSP research in the peri-urban interface system programme commenced in two medium sized city regions: Kumasi in Ghana and Hubli-Dharwad in India. A systems based approach was adopted to study effects of urbanisation upon natural, human and financial resource flows, to characterise the main stakeholders, and develop ways in which natural resource management and agricultural production could be improved. Over the past five years, these studies have produced a large volume of information, research reports, a few published articles, and a large database with a Geographical Information System (GIS) interface for Kumasi and its region.

Following a change in UK Government policy, DFID produced a White Paper on "Eliminating world poverty: A challenge for the 21st century", which set a new agenda for the British aid programme, embracing an explicitly stated poverty alleviation goal. As a consequence, the research goal stated in the NRSP's logical framework of "Productivity and productive potential in the peri-urban interface production systems increased through the application of systems-based approaches", was in 1999 modified to "Livelihoods of poor people improved through sustainably enhanced production and productivity of renewable natural resource systems". These new terms of reference required research projects to adopt a livelihoods approach with the emphasis upon poverty alleviation.

NRSP commissioned a project, "Consolidation of existing knowledge in the peri-urban interface system" (project number R7549: see Appendix) to position itself with regard to future direction in the research programme. The report produced was the result of three months of multi-disciplinary teamwork by a group of nine researchers based at the University of Wales in Bangor, University College London and the University of Birmingham. The work comprised a review of over 90 written documents and other research outputs (e.g. CD-ROM) emanating from PUI projects funded by NRSP. This book is an edited version of the R7549 final report.

Project R7549 had a specific set of terms of reference, to consolidate the knowledge generated by previous research, assess whether this knowledge was adequate for development of new calls for research, and identify any significant knowledge gaps resulting from the change of programme direction which should be addressed before activities outlined in NRSP's new PUI logical framework could proceed. This required that some data had to be looked at a new way, sometimes in ways that the original researchers could not have anticipated. In the final report of project R7549, and in this book, opinions were expressed concerning the extent to which projects operating under the previous terms of reference met the terms of NRSP's new purposes. When the reader comes across such expressions of opinion, they should be understood in the context just outlined. Although many of the opinions are relevant to findings arising from particular projects, they nevertheless have wider applicability for research programmes in other locations.

In consolidating the existing knowledge and identifying gaps in knowledge, the team was guided by the sustainable livelihoods framework developed by the Institute of Development Studies, University of Sussex, and adapted to accommodate DFID's particular concerns, as described in the book '*Sustainable Rural Livelihoods: What Contribution can we make?*' (Carney, 1998a)

At the core of this framework lies an awareness that individuals draw on five types of capital assets to build their livelihoods, namely: natural, human, financial physical and social. Opportunities are constrained or enhanced by potentially transforming structures and processes which generally lie beyond the control of individuals, as they are the result of institutional factors (policies, laws, customs) and the operation of markets. A central tenet of the sustainable livelihoods approach is that poverty is not a static or permanent phenomenon, but a condition into and out of which people move in response to the opportunities, shocks and stresses that they experience. In the context of the PUI there is a need to understand the specific opportunities that arise from the meeting of urban and rural processes and how these affect the livelihoods of the poor.

For some enterprises (e.g. livestock) the transition from urban to peri-urban through the peri-urban interface is a gradual one. The distance over which inputs to the enterprise (fodder) and waste outputs from the enterprise (manure) must be transported primarily mark the boundaries of this transition zone.

As a city expands in area, so the zones representative of 'urban' and 'peri-urban' increase. The peri-urban zone is in a state of rapid change. Land that earlier met the definition of 'peri-urban' becomes 'urban' and truly rural land now becomes 'peri-urban'. Consequently, all agricultural activities are likely to be transient in character and the incentive to invest in capital developments very small.

The rest of this chapter presents an introductory overview of Hubli-Dharwad and Kumasi and the regions in which they are located. An understanding of the issues and processes that have been documented in the NRSP research is best seen in the context of the differences and similarities between the two city regions, particularly as regards their peri-urban interfaces. The aim of these profiles is to locate the discussion of the following chapters by providing a set of comparable basic information on the recent development of the two cities and their peri-urban areas. The profile starts with a brief statistical overview of India and Ghana, placing particular emphasis on human development and basic agricultural issues. In the following section the two cities are examined in parallel with the help of a basic set of comparative data for 1993 drawn from a large database compiled by the United Nations Commission on Human Settlements (UNCHS, 2000). The comparison centres around human and economic development, as well as environmental issues and infrastructure.

An overview of India and Ghana

The choice of India and Ghana as locations for the NRSP research on the peri-urban interface was the result of a process of selection by a team of researchers, and because they are both DFID target countries. With a population 54 times larger and an area fourteen times as big, India is by far a much larger country. And yet, when seen in relation to their respective sizes, the extraordinary cultural and linguistic diversity that marks them both would seem to highlight an important commonality. However, as in the reports reviewed there were no data reported, an area not covered in this book is culture.

Table 1.1   Basic statistics for India and Ghana

Indicator	India	Ghana
Population, 1998 (millions)	980	18
Annual population growth rate, 1990-1998 (%)	2.0	3.1
Share of urban population, 1998 (%)	28	37
Population density, 1998 (people/km^2)	330	81
GNP per capita measured at PPP[a], 1998 (US $)	1,700	1,610
Average annual GDP growth rate, 1990-1998 (%)	6.1	4.2
Life expectancy at birth, 1998 (years)[b]	62.6	60.0
Adult literacy rate, 1998 (as % of age 15 and over)	55.7	69.1
Population below poverty line[c] (%):		
Rural	36.7	34.3
Urban	30.5	26.7
Total	35.0	31.4
Population with access to safe water, 1995 (%):		
Rural	82	52
Urban	n.a.	88
Irrigated land, 1994-1996 (% of cropland)	32.0	0.1
Arable land (has. per capita), 1994-1996	0.17	0.16
Agricultural productivity (value added per agricultural worker; 1995 US$), 1995-1997	343	533
Annual deforestation, 1990-1995		
Km^2	-72	1,172
Average annual change (%)	0.0	1.3

n.a.: Not available;a: Purchasing power parity; b: Data from UNDP (2000); c: Nationally defined poverty lines; Survey years: India, 1994; Ghana, 1992.
Source: World Bank (1999), except where indicated.

The research that informs this publication are human and economic development issues, including the role that urban-based activities, agriculture and natural resources play in both. The statistical information in Table 1.1 offers a parallel summary of both countries in some of these dimensions. In the 1990s, Ghana's population grew at a much faster rate than India's where birth control policies were successfully implemented well before Ghana. In population terms, India is much more densely populated but it is also less urbanised. Both countries experienced relatively healthy rates of economic growth in the 1990s, and by the end of the decade their per capita income (when adjusted for purchasing power parity) was very similar.

A much higher proportion of India's cropland is irrigated than in Ghana, where irrigation is negligible, although the availability of arable land in relation to their population is very similar in both cases. Despite greater mechanisation (as measured in tractors in relation to population) of agriculture in India, Ghana's productivity per worker is over 50% higher than India's. But while in India de-forestation has been reversed, in Ghana it is advancing apace, losing over 1000 km^2 every year.

The urban cores of Hubli-Dharwad and Kumasi

The two case studies have provided a substantial body of information that has helped advance our understanding of the nature of the peri-urban interface in two rather dissimilar medium sized cities, in terms of natural resource management and how the livelihoods of its poorer inhabitants have changed in recent years.

Kumasi is the second largest city in Ghana after the capital Accra, and centre of a large area which historically encompassed the Ashanti Kingdom (Figure 1.1). It is located in the tropical forest ecozone about 300 km northwest of Accra. Since the 19th century, it has been important as a cocoa growing and trading centre. The urban area proper corresponds to the jurisdiction of the Kumasi Metropolitan Assembly (KMA). "By virtue of its geographical position and of its road connections, Kumasi constitutes probably the most important centre . . . in the country. . . its markets . . . constitute the point of arrival and departure of goods produced locally as well as in neighbouring countries" (Corubolo with Mattingly, 1999, p. 1).

Hubli-Dharwad, in southwest India (Figure 1.2), is a conurbation comprised of the urban areas of Hubli and Dharwad which are separated by a distance of some 20 km. The two were brought together under the Hubli-Dharwad Municipal Corporation (HDMC) in 1962, thus making it the third largest urban agglomeration in Karnataka State (after Bangalore and Mysore). "Hubli is the larger city, a centre of commerce, trade and industry, and also the centre for transport within the region, due to its position on road, rail and air links with Bangalore and Bombay, both important centres of trade and industry. Dharwad, to the west of Hubli, acts as the administrative centre and hosts the city's higher education institutions" (Budds with Allen, 1999, p. 1).

Statistical comparison across national boundaries is a task fraught with difficulties. This is because governments usually have their own approach to gathering, processing and publishing statistical data, which rarely conform to internationally agreed definitions. Additionally, such definitions often change from one year to the next even within the same country. Thus, an international database providing a range of comparable indicators for a large number of cities or localities is a very valuable tool. A team of international and local experts led by UNCHS assembled the indicators used in this section. By and large, they refer to the urban agglomeration, "defined as the built-up or densely populated area containing the city proper, suburbs, and continuously settled commuter areas" (UNCHS, 2000). Unfortunately, the Internet version of the database does not provide more specific information on what these areas encompass in the two case studies cities under consideration here.

As far as possible, the city-specific data seek to conform to the same definition across national boundaries, and they all refer to the year 1993, providing a composite picture of the two localities, particularly as regards the urban core of the metropolitan area. Comparative data are not available for the two peri-urban interfaces, as even the definitions of what constitutes them differ from one city to the other.

Table 1.2 shows that population growth is considerably faster in Kumasi. At the rates observed in the early 1990s, it would take around 30 years for the population of Hubli-Dharwad to double, but only 18 years in Kumasi. Differences in the two growth rates are partly a reflection of national differences in the rates of natural growth in the respective countries, but to a lesser extent they also reflect a somewhat higher proportional influx of migrants into Kumasi and its periphery.[1] This is a consequence of the fact that Kumasi is not only the second largest city in the country (while Hubli-Dharwad occupies 44th place in India) but as was noted earlier, it is also a major regional trade centre.
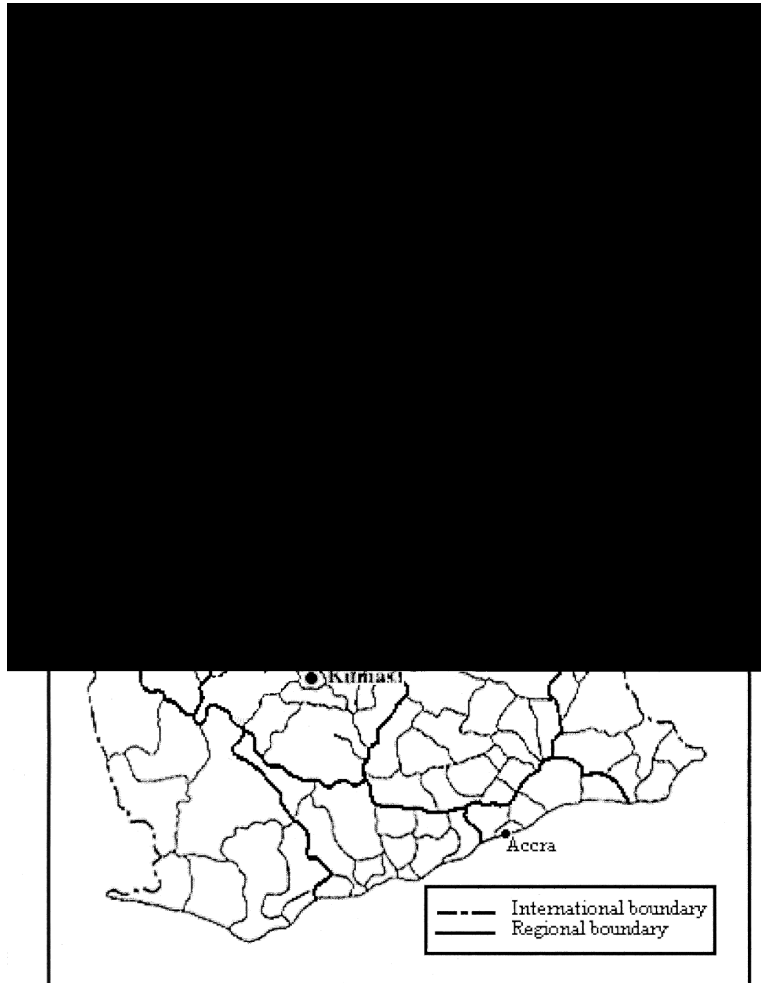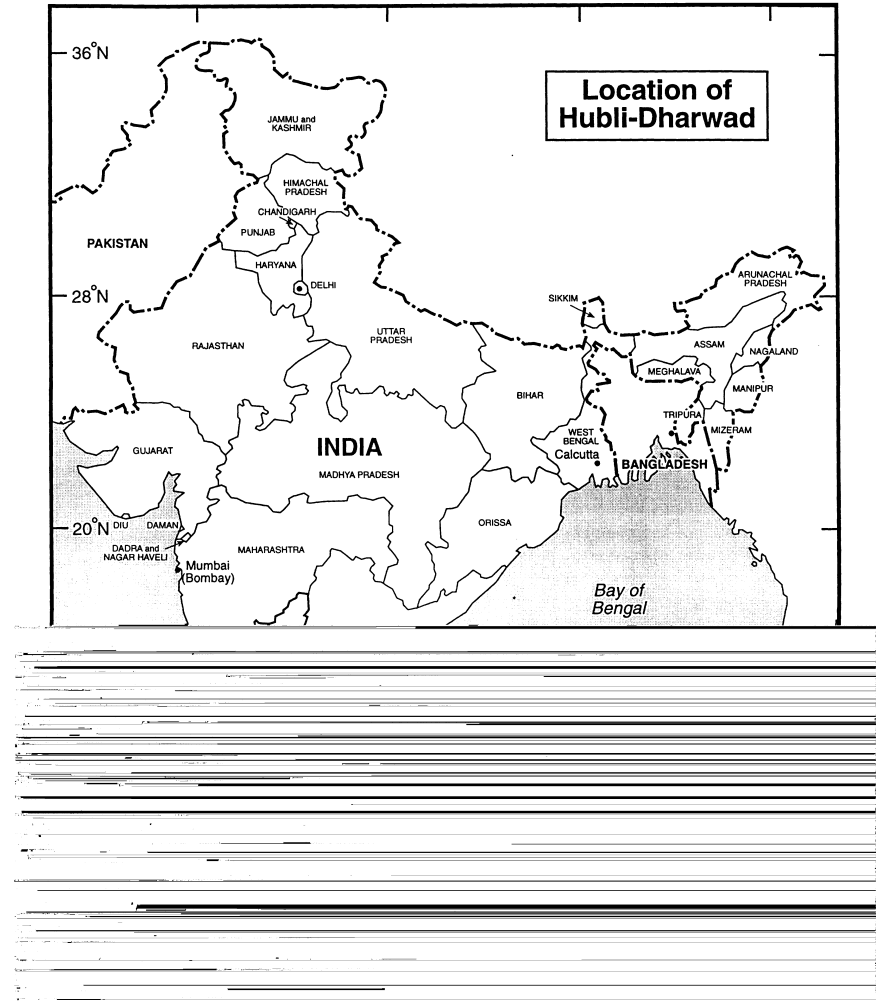
Figure 1.1 Location of Kumasi in Ghana

Figure 1.2

Source*:* University of Birmingham *et al*. (1998a, p. 4)

Table 1.2   Population data for Hubli-Dharwad and Kumasi cities, 1993[a]

Indicator		Hubli-Dharwad	Kumasi
Population (000s)			
	Female	326.8	290.1
	Male	351.6	245.2
	Total	678.4	535.3
Annual population growth rate (%)		2.3	3.9
Rank among the country's cities by population size		44	2
Residential density (people/ha.)		231	n.a.
Annual rate of formation of new households (%)		3.1	2.6
Average household size		5.6	5.5
Share of women-headed households (%)		12.5	n.a.
Household income distribution (average household income in US$ per year)			
	Quintile 1	284	405
	Quintile 2	691	662
	Quintile 3	1,092	707
	Quintile 4	1,494	1,162
	Quintile 5	2,009	1,171
Income disparity (quintile 5/quintile 1)		7.1	2.9
Child mortality among under 5-year olds (%)		2.29	n.a.
Informal employment (% of employed population)		30.7	77.1
Local government employees per 1,000 population		4.25	1.32

n.a.: Not available

a.   Cities defined as the built-up or densely populated area containing the city proper, suburbs, and continuously settled commuter areas

Source: UNCHS (2000)

Another marked difference between the two cities is the sex ratio of their populations. While in Hubli-Dharwad males comprised 52% of the total, in Kumasi they accounted for just under 46%.[2] This is the result of differences in in-migration, as males in the region around Kumasi are more likely than women to migrate away from the region, to the capital, Accra, or even to international destinations. New households are forming faster in Hubli-Dharwad than in Kumasi, probably the result of the sex imbalance, but also of a population

structure marked by a smaller proportion of children and teenagers and a correspondingly higher share of people in child-bearing and retirement age.

Income disparities are more marked in the Indian city, where the richest 20% of the population earn over seven times as much as the poorest 20%; in Kumasi, by contrast, the ratio is less than three. The data also suggest that the poorest groups in the Indian city earn on average less than their counterparts in Kumasi, although the difference between the poorest quintile and the next groups up is more marked in Hubli-Dharwad. Thus, while the poorest are considerably worse off in the Indian city when household income is measured, the middle and high income groups appear to be comparatively better off.[3]

While 77% of Kumasi's labour force work in the informal (or unregistered) sector, less than a third of Hubli-Dharwad's do. This is probably a reflection of both the greater control exercised by the Indian government over unregistered activities (such as trade and manufacturing), and the greater significance of local government in providing employment (three times higher compared to population size).[4]

Although by no means high compared to developing country standards, the population in Hubli-Dharwad generally enjoys better coverage of basic services and infrastructure (Table 1.3). There are fewer patients per hospital bed, while considerably higher proportions of local households have connections to water, sewerage and electricity networks. Individual consumption of water is closer to international standards Hubli-Dharwad, whereas telephone coverage is better in Kumasi, with nearly a third of all households having access to it.

In cities with populations of comparable size (see Table 1.2), the average times taken for commuters to reach their workplace is very similar. There are noticeable differences in the transport modes available to commuters, however, with over half travelling by bus or minibus in Kumasi, and 10% by private car, while in Hubli-Dharwad these two modes account for less than 40%. Motorcycles, by contrast, are much more widely available in the Indian city, providing nearly 20% of all daily trips to work.

In 1993 per capita annual capital expenditure by the local government in Kumasi was 80% that of Hubli-Dharwad. Expenditure on road infrastructure accounted for half of this in Hubli-Dharwad but only for 17% in Kumasi. It is possible that this was the result of a one-off programme of road investment in 1993, rather than the result of a long-term trends.[5] Major services such as water and electricity are the responsibility of national government enterprises, rather than of the local government represented by the KMA (Devas and Korboe, 2000).

Table 1.3. Services and infrastructure in Hubli-Dharwad and Kumasi , 1993[a]

Indicator	Hubli-Dharwad	Kumasi
Number of persons per hospital bed	721	2,094
Percentage share of households connected to:		
Water	37.6	28.0
Sewerage	37.4	11.9
Electricity	74.1	58.7
Telephone	7.4	29.1
Consumption of household water (litres/person per day)	92.1	9.85
Median price of water (US$ per 100 litres)[b]	0.08	n.a.
Solid waste generated per capita (m³/year)	0.37	n.a.
Transport modal split (% of all work trips made by):		
Private car	2.6	10.4
Train/tram	0.2	0.0
Bus/minibus	37.1	55.0
Motorcycle	17.6	2.0
Bicycle	7.1	4.6
Foot	29.5	28.0
Other	5.9	0.0
Mean travel to work (minutes)	22.0	20.0
Automobile ownership (cars/1,000 inhabitants)	48.7	102[c]
Annual expenditure on road infrastructure (US$/person)	0.78	0.20
Annual local government capital expenditure per person (US$)	1.42	1.19

n.a.: Not available;

a   Cities defined as the built-up or densely populated area containing the city proper, suburbs, and continuously settled commuter areas

b   Median price paid per hundred litres of water in US dollars, at the time of the year when water is most expensive

c   Estimated average for all zones in the city. From Annex Table 2.9 in Korboe *et al* (1998).Source: UNCHS (2000), except where indicated.

An overview of the book

Following this introductory chapter, chapter 2 provides overviews of the peri-urban interfaces of Hubli-Dharwad and Kumasi, stressing particularly a range of issues such as spatial, human and economic development, the institutional framework under which the peri-urban interface has developed in recent years and the decision-making processes that are likely to shape the future of the interface, particularly for its poorer inhabitants.

Chapters 3 to 5 summarise the natural resource base of the PUI of the two cities, considering cropping and livestock systems, and soil, water and waste

management, respectively, and how the process of urbanisation has affected these, where this is known. Chapter 6 summarises existing knowledge on the livelihood strategies of poor households in the Hubli-Dharwad and Kumasi PUI. After a discussion on the nature of poverty in the PUI, the chapter outlines the sustainable livelihoods framework adopted by DFID for natural resources research. This is then used to examine the nature of poverty in the two city regions, and to examine how processes there affect the five capital assets available to the PU poor.

Chapter 7 is different in nature from earlier chapters, as it concentrates upon one particular technology, Geographical Information Systems (GIS). This management and descriptive tool has grown in importance in parallel with the power and availability of the computing systems upon which it depends. In a rapidly changing environment such as the PUI, the ability to rapidly enter new data and obtain outputs renders this a potentially powerful instrument for planning and analysis. This potential was realised for Kumasi, and significant investment was put into developing GIS application suited to that location.

Notes

1 In-migration was a much more important contributor to Kumasi's population growth in the decades before 1980. In 1960 it is estimated that it may have contributed two-thirds of the growth rate, and slightly over half in 1970. By the 1984 census, it is estimated it contributed a mere 6.2% (Korboe *et al*, 1998). In the absence of census figures after 1984, it is not possible to ascertain the extent of its contribution in the 1990s.

2 In Dharwad District the ratio of women : men was 944 : 1,000 men in 1991 (Vyasulu, 1997).

3 Care must be exercised in using income as the only measure of poverty or wealth, as several authors have pointed out (e.g. Wratten, 1995) and the discussion on sustainable livelihoods elsewhere in this book illustrates.

4 Kumasi is believed to have a larger shadow economy than Accra (Korboe *et al*, 1998).

5 Expenditure priorities change from one year to the next in government budgets, and data for 1993 only are presented here. As an example of the nature of these changes, in Kumasi capital expenditures accounted for nearly half of its expenditures in 1997, two items, street lighting and waste skips, representing two thirds of KMA's expenditures from its own resources; a much greater volume of

capital expenditure was budgeted for 1998, where street lighting accounted for a mere 15% but the construction of a market and an office building made up over half (Korboe *et al*, 1998).

2 Profiles of Hubli-Dharwad and Kumasi

An overview of the peri-interface of Hubli-Dharwad

Defining the peri-urban interface

The Hubli-Dharwad peri-urban interface may be loosely characterised as the area within the Hubli-Dharwad city region but outside the core urban area and encompassing the villages connected to Hubli and Dharwad by city bus services (University of Birmingham *et al.*, 1998b). It includes five taluks around the city within Dharwad District: Dharwad, Hubli, Kalghatgi, Kundgol and Navalgund.

Within the city region there are differences in climate and physiography: "Kalghatgi taluk to the southwest of the city is part of a hill area, with higher rainfall; Dharwad taluk is in a semi-hill area, and Hubli, Kungdol and Navalgund are plains areas, in which rainfall decreases to the east, particularly in Navalgund and Kungdol taluks" (University of Birmingham *et al.*, 1998b, p. 16). The quality and type of soils also varies between different parts of the region. "Black cotton soils are characteristic of the northern and eastern sides of Hubli-Dharwad, contrasting with the medium red soils in the south and west of the city. Kalghatgi taluk, the southern part of Dharwad taluk and the southern part of Hubli taluk have red soils and higher rainfall, increasing to the southwest, while Navalgund taluk, Kundgol taluk, the northeast of Hubli taluk, and the northern part of Dharwad taluk have black cotton soils" (ibid.).

In 1991, the city region had a population of 1,428,174, including 648,298 in Hubli-Dharwad Municipality, of which 50.5% were classed as urban. Population in the remaining rural and semi-rural areas grew at a rate of 2.7% per year between 1981 and 1991, faster than that in Hubli-Dharwad, which grew at 2.1% per year (University of Birmingham *et al.*, 1998b, pp. 16-17). In 1991, the average population size of villages varied from 1,394 in Kalghati taluk, to 2,722 in Navalgund. Although larger villages tend to be located in the black cotton soil irrigated areas, in the 1980s they also tended to lose population through out-migration while in the south, particularly in Dharwad taluk, villages have attracted in-migrants. Greater proximity to the city is also linked with more rapid growth compared to more distant locations.

The regional and city economies

Current trends in peri-urban farming systems

Production activities in the peri-urban interface of Hubli-Dharwad are characterised by heterogeneity in the physical environment and farming systems, and also by patterns of dynamic change in some areas, while others have remained relatively stable. These factors have lead in turn to varying levels of productivity and prosperity and have had differential effects on the livelihoods of peri-urban residents.

Hubli-Dharwad is located in a predominantly rural region where agriculture is the principal economic activity due to the productive nature of the soils. The Baseline Study provides an initial characterisation of the main changes in peri-urban production activities, focusing mainly on farming systems (Hunshal, 1997). Changes in cropping patterns appear to be linked to the opening-up of the local market (city-region), and also increased access to wider regional markets including those in Bangalore and Bombay via Hubli-Dharwad. A trend has been established illustrating that farming patterns have varied on each side of the city.

These areas are also characterised by differences in type and form of production, land size, and access to irrigation and marketing. As a generalisation, to the east of the city farming is more urban-oriented, which means that there has been a diversification from subsistence to commercial cropping in order to satisfy urban markets and also due to increased irrigation (*e.g.* floriculture). To the west farming is rural-oriented, where farming is still geared towards traditional subsistence crop production, where crops such as rice predominate. Farming has also seen a trend towards mechanisation as a replacement for more traditional farming techniques using plough animals, which is also thought to have led to a decrease in demand for manual labour and also in the availability of organic manure (Hunshal, 1997).

Peri-urban farmers are experiencing labour shortages, due to the growth of industry and construction and the higher wages available for these activities. This trend is particularly observable among the younger generation, as agriculture as a livelihood is regarded as backward. A response to this problem has been a shift towards crops that require less labour input, such as mangoes (Hunshal, 1997).

Irregular wages and underemployment both in the agricultural and non-agricultural sectors in the villages have led to an exodus of the rural population towards the city in search of employment opportunities. This is mainly due to uncertain rainfall and poor irrigation facilities that in turn have reduced agricultural production. School dropouts are increasing due to the demand for family and child labour both in agriculture and factories because family income is not sufficient to meet the basic needs. The overall effect of the change is that people have additional employment opportunities during non-harvest seasons in agriculture, and have good access to transportation facilities (Budds with Allen, 1999). The social groups most affected are both farmers and farm women having less than 6 ha of rain-fed (e.g. not irrigated) land who seek employment in the cities during non-harvest season. The Baseline Study identified that these trends are also related "to changes in land tenure, with new (urban-based) land owners coming into the picture, and small holders seeking to minimise risks and improve security of market access" (University of Birmingham *et al.,* 1998a, p.62). However, who sells the land and what happens to the proceeds are important questions that remain unanswered.

The peri-urban interface is undergoing a transition from the use of fuelwood to the use of gas (Liquefied Petroleum Gas - LPG) for energy, especially by lower-income groups. The use of forests for fuelwood has become a concern, and fuelwood is now being commercially farmed. A cheap alternative fuel source for low-income groups is agricultural waste, for instance cotton stems, however its collection is time-consuming. Electricity is extended to the more accessible villages, where provision is between 80 and 100%, however the supply is subject to frequent power-cuts (Hunshal and Nidagundi, 1997).

Water is a valuable commodity in the peri-urban interface of Hubli-Dharwad, as it is scarce in much of the area, and agriculture in the drier black cotton soils depends on it for irrigation. There are two sources of water: reservoirs (and piped to destination), or borewells which extract groundwater directly. Piped water is extended to some peri-urban villages in the form of standpipes and paid for by the local administration. There have been reports of water shortages from standpipes due to energy shortages, which is needed to pump the water. In more remote villages borewells are more common. Borewells are also used for irrigation and there have been reports of an excess of borewells, which in turn has led to the lowering of the water table and lack of underground pressure to bring the water to the surface and also water of a brackish nature. There is possible contamination of groundwater from landfills (Khan and Mulla, 1997). There is a lack of information about water pollution, although there is concern about the quality and quantity of freshwater both in reservoirs and borewells. The lack of drainage is also a problem as is a lack of water for small irrigation schemes (ibid.).

Changes in marketing opportunities, off-farm employment and availability of inputs for peri-urban production activities have been identified in several documents as the main factors likely to be directly influenced by the proximity and connectivity to the city and by intense urban-rural interactions (Hunshal, 1997; Budds with Allen, 1999; Patil, 1999; Allen, 2000). However, there is still little information on the regional trends that are driving these changes. In this sense, it can be argued that the characterisation of farming systems has been focused so far on changes at the peri-urban micro-scale but there is still insufficient knowledge to explain the forces driving rural-urban linkages at the regional level.

Current trends related to urban expansion and industrialisation

The peri-urban interface of Hubli-Dharwad can be loosely geographically delimited as an area surrounding the twin cities within which urban bus services are extended, thus distinguishing it from rural areas. The area can be characterised as undergoing changes due to the growth of the twin cities and the increased connectivity with them. The peri-urban areas of Hubli-Dharwad are represented by villages outside the twin cities which have experienced such changes. Furthermore, the fact that Hubli and Dharwad have been brought within a single municipal district has meant that the villages located in the area between the two cities have lost their rural character and have become peri-urban, which is a unique feature of the structure of the Hubli-Dharwad city-region.

In 1991, land not available for cultivation occupied 4.1% of the total area of the revenue villages in the five taluks of city region. However, between 1981 and 1991, there was a significant decline in the area of land unavailable for cultivation (34.6%) (University of Birmingham *et al.,*1998a, p.22). Although greater land pressures were not exclusively linked with proximity to the city, more recent reports (Budds with Allen, 1999, Patil, 1999) suggest that peri-urban villages are undergoing changes in land ownership, arising when the government displaces landowners with compensation and sells the land to the private sector - usually industry - for development. However, little is known about how much land is being converted and for what purposes, whether the land is being converted for residential, speculative or industrial purposes.

Furthermore, there is no characterisation of who is buying land and for what purposes, whether it is urban dwellers buying land for investment or speculative purposes, farmers from other villagers or new industries buying agricultural land for industrial purposes.

The state promotes the industrialisation of the city region based on Hubli-Dharwad's strategic location and good connections with Bombay and Bangalore, and the availability of water and forest resources and cheap labour, all of which make it a potentially prime location for industry. However, despite state policy promoting industrialisation, there are several infrastructural constraints that limit its viability in the Hubli-Dharwad city-region. The most significant of these is a lack of public investment in the necessary infrastructure due to constraints to capital investment (resulting from structural adjustment) for new projects and the administrative difficulties of bringing private sector involvement into public works. The most notable example of this is the power sector. Hubli-Dharwad suffers electricity shortages which are common throughout India, and these shortages are worse the greater the distance from the municipal area, that is, peri-urban areas. Water shortages represent a similar constraint (Budds with Allen, 1999).

Institutional structures and decision-making processes

In addition to central government, three levels of government administration have a presence in the city region of Hubli-Dharwad: state, municipal (urban) and rural. The two principal bodies active at the municipal level are the Hubli-Dharwad Municipal Corporation (HDMC) and the Hubli-Dharwad Urban Development Authority (HDUDA). The rural level is governed by the Panchayat Raj (council) system, divided into three further sub-divisions, Zilla (district), Taluk (sub-district) and Gram (two or three villages) Panchayats. Although none of these is concerned with land use planning and natural resources management, they are responsible for the allocation of resources and the implementation of programmes and schemes defined by the Central and State government (Subhas, 1997; Budds with Allen, 1999).

The central government has introduced several policies and incentives to farmers in order to improve agricultural production and to secure access to land for the poor. Thus, for example, if people earn less than 2,000 rupees per year, they are eligible for a grant of land to practice agriculture. Landless people in the taluk and people who hold insufficient land receive priority. There are special regulations of grants of land to lower castes, and a certain proportion of all land (not less than 50%) granted must go to these castes, if they are present. Although

land cannot be bought by civil servants, this is ignored in practice (Nidagundi, 1999).

The Deputy Commissioner has the power to lease lands (subject to availability) to farming co-operatives, village panchayats and taluk development boards and any company or association engaging in agriculture, industry, or public utilities. Land leased for agricultural purposes is subject to the following conditions: land must not be permanently destroyed, the lessee must not sub-let or abandon the land, land must be cultivated personally by the lessee, land must not be used for other purposes, and annual rent is 10 times the land revenue plus water rates not exceeding a certain value according to the class of land (Nidagundi, 1999).

Under the Karnataka land reform of 1974, laws were introduced in favour of land tenants, giving a person illegally cultivating land belonging to another person the status of tenant. The result has been that many large landholdings have been reduced and land has been redistributed among the landless (who are now tenants), resulting in an overall increase in production. Poor people who were working under landlords were also given tenant status, and this has improved their livelihoods. This was a very strong measure taken by the government for poverty alleviation but little is known about its effectiveness and impact on the peri-urban poor (Nidagundi, 1999).

In relation to agricultural policies, the central government has provided regulated markets in each taluk, has introduced policies to ensure that farmers' crops are measured accurately and that farmers can sell directly without middlemen, do not incur unforeseen expenditures and are not responsible for losses once their produce has been sold (Nidagundi, 1999). However, although access to markets by farmers has increased, because of the growing markets in Hubli and Dharwad and also better connections to take their produce to market, they complain of low prices for their produce, especially when sold to the government via middlemen (Budds with Allen 1999; Allen, 2000).

The networks for the marketing of farming products and the main stakeholders involved in these networks are also characterised in the Baseline Study (University of Agricultural Sciences *et al.*, 1997; University of Birmingham *et al.,* 1998a, 1998b). Agricultural produce markets appear to be highly fragmented, with weak links to the state and the national and international markets. Poor farmers were found to avoid harvesting crops of higher productivity and risk in order to avoid price and post-harvest and storage risk. Key factors that demand further consideration are the constraints to the access of poor farmers to credit and to marketing organisations and information.

With regards to agriculture marketing, the government has established an Agriculture Produce Marketing Committee which provides loans to farmers (Nidagundi, 1999). However, in practice other institutions appear to be the main sources of loans for farmers. Villagers in Mugad, Gokul, Kotur and Aminbhavi ranked as one of their principal concerns the fact that farmers are increasingly taking loans from money-lenders and other financial organisations, to whom they are forced to sell their produce if they are unable to repay. When yields are low, they are forced to mortgage their lands (Patil, 1999). The formal and informal institutional mechanisms available to access credit require further investigation.

Among the government initiatives in support of agricultural production, there is a Cereal Improvement Programme through which farmers are given field demonstrations, are trained, and are then paid 5,000 rupees per season to test cereal and rice production. Similar schemes exist for pest management, production of improved seed, experimentation with compost made by vermiculture etc. Irrigation policies specify that in order to preserve levels of the water table for irrigation, borewells must have a minimum distance of 300 feet between them. This rule appears to be grossly violated in practice, especially on private land. The State Government has launched a scheme (*Ganga Kalyana Yojane*) in order to increase access to irrigation (and therefore productivity) through the provision of hand pumps fixed to borewells. The misuse of such hand pumps has been reported as a problem but has not been further investigated (Nidagundi, 1999).

Caste occupations like pottery, fishery and bamboo product making are least affected because profit is inversely proportional to the investment (University of Agricultural Sciences *et al.*, 1997). However, little is known about the contribution of non-farming productive activities to reduce poverty in peri-urban villages. In order to cope with the changes affecting farming production, women have taken up work in factories and also sell vegetables, cereals and pulses in the weekly markets of Hubli and Dharwad. Many young people and women have also taken up dairying (Patil, 1999). In Mugad, the women's association is well organised and has put in place a small savings scheme. At the local level, several community organisations appear to play a key role in terms of supporting and diversifying local livelihood strategies. Little is known, however, about the strengths and weaknesses of these organisations. Further research on the role played by these organisations in expanding the social capital of poor peri-urban dwellers is required, in order to guarantee that future interventions are supportive of current initiatives at the grassroots level.

From an institutional point of view, the decision-making arrangements and mechanisms affecting peri-urban production activities appear to be highly fragmented and lacking attention to environmental and poverty concerns. However, this does not mean that there is an institutional vacuum concerning the management of peri-urban productive systems. Further research is required on the effectiveness of existing policies in supporting farming systems and their impact on poor farmers, with particular attention paid to the increasing engagement of women as agricultural labour force. Aspects of particular relevance to be further examined include the impact of these policies to improve market opportunities and access to credit, availability of labour and draft power, and the role of village organisations, such as producer cooperatives and women's organisations in addressing these issues at the local level.

In relation to urban development, the main institutions directly involved in land-use planning have been characterised in the Baseline Study (Subhas, 1997). The Hubli-Dharwad Urban Development Authority (HDUDA) is responsible for the planning of urban areas including areas of urban expansion and takes the stance of accommodating urban growth rather than making specific land use decisions. The Hubli-Dharwad Municipal Corporation (HDMC) is responsible for implementing urban plans and the maintenance of urban public utilities.

The rural-oriented Dharwad Zilla Panchayat (DZP) is primarily concerned with short-term socio-economic planning and adopts a non-spatial planning approach, with no attention to land-use decision-making, physical planning or environmental concerns. The role of the DZP is to allocate financial resources to specific project proposals by Village Development Committees at the Gram Panchayat level (lowest-level village authorities) in accordance with Central and State government directions. "The largest spending is on health, education, and public works – roads, water, buildings, but the Zilla Panchayat is split into 33 departments. Each department has their own sources of information which are not shared with other departments, and each has their own separate linkages with other levels of government. The Chief Executive Office is responsible for co-ordination, and together with the Planning Unit and the Deputy Secretary (Development) appears likely to be able to facilitate contacts with stakeholders in the district" (Subhas, 1997, p. 110).

There is a high degree of centralisation at the state level, which means that neither the municipal authorities nor the Panchayati Raj system have significant power or financial autonomy to carry out independent decision-making (Sundaram, 1995). This is exemplified in the process of industrialisation and urbanisation promoted by the State government.

The state tends to impose a top down approach, with state-wide policies on industry and urbanisation drawing little resistance from the rural authorities. Although the Panchayat has the right to approve (or reject) requests for land conversion, in practice the state government has the power to acquire the land and overrule the lower-level Panchayat authority (Budds with Allen, 1999).

The process of planning also appears to be heavily politicised. For instance, despite holding regular elections, the Panchayati Raj system is also characterised by patriarchy and bureaucracy. In general, peri-urban villagers oppose moves to incorporate them into the Hubli-Dharwad municipality because they do not want to lose their Gram Panchayat form of local administration, as this would mean that they would be absorbed and dominated by the municipal authorities with less say in the running of local matters than at present. Losing their local form of government would also mean paying higher taxes corresponding to the municipal authorities and losing rural subsidies for farming, for example access to subsidised credit. They also fear increased air and water pollution from the growing city and loss of common land and open space (Patil, 1999; Allen, 2000).

As mentioned above, none of the above authorities give attention to environmental planning and management for the peri-urban interface, not even the HDUDA which supposedly takes a longer-term and more strategic approach. Both the Karnataka State government and HDMC have pollution control departments; however, no central department of the environment exists within any of the authorities responsible for the Hubli-Dharwad city-region. There is a general lack of information on industrial pollution in Hubli-Dharwad, although there are many undocumented cases of bad pollution. Although pollution control exists in the legislation, politics and corruption hinder its enforcement. Potential conflicts may arise in the future due to environmental problems that to date have not been planned for (Nidagundi, 1999).

In general, there is an absence of communication and co-operation between the planning authorities, especially the HDUDA and HDMC bodies, in spite of the fact that their realms overlap to a certain degree. In order to counteract this, the state government has set up a District Planning Board with representatives from all of the local planning authorities. The Baseline Study highlights the scope to integrate and enhance the planning mechanisms of both the HDUDA and the DZP through the implementation of the Board and also the need to support the work of both agencies by providing research support and policy advice from the findings of existing and future research on the peri-urban interface (Subhas, 1997). However, little is known about the specific role and responsibilities of the Board and also about the factors that hamper its implementation.

The main policy mechanisms identified to guide land-use and ameliorate the impact of urban expansion on peri-urban areas are the Comprehensive Development Plan, devised each ten years by HDUDA, and more specifically a designated green belt within the plan, earmarked for agriculture and future expansion of settlements. Both mechanisms appear to have taken little account of environmental considerations and also lack a broader vision of regional development to promote a more efficient use of renewable natural resources in the PUI (Nidagundi, 1999).

Green belts are designated around towns with populations exceeding 50,000, as is the case of Hubli-Dharwad. The green belt is maintained with a view to contain future development or expansion of a settlement. During the 1970s and 1980s, some of the green belt was converted for residential and industrial uses. The green belt and the 18 villages covered by the 1988 Comprehensive Development Plan (HDUDA) remain under the jurisdiction of the local Gram Panchayats and the Taluk Panchayat. HDUDA has enforcement powers, but not political status to apply these powers in practice. In addition, the Urban Development Authority has no statutory controls beyond the local planning area, so difficulties have emerged in enforcing the 1988 Plan (Nidagundi, 1999).

In contravention of the plan, some local panchayats have granted formal permission to change the use of agricultural land. Some previously agricultural land around Hubli-Dharwad has been converted to residential use, some of which was done illegally, with no provision for basic infrastructure such as electricity, water and drainage. Land speculators are reported to have offered half of the market value to farmers, built in inadequate roads and sold off plots of land to low income groups (University of Birmingham *et al.*, 1998a, p.108). Migrants to the city who have been unable to purchase plots have illegally occupied other areas. However, in the studies done so far, there is very little coverage of unauthorised and speculative land developments. The Regularisation of Unauthorised Construction Act (1995) has encouraged or supported unauthorised developments. In addition to this, pressure may be exerted on the Slum Clearance Board to class these settlements as slums so that services have to be provided by the government.

Several mechanisms are in place to prevent land conversion and speculation (Town and Country Planning Act, Revenue Act and Urban Land Ceiling Act). Since 1997, the Development Authority has started to coordinate efforts with the Municipal Corporation and the Dharwad District Deputy Commissioner to stop the growth of unauthorised settlements (University of Birmingham *et al.*, 1998a, p.109). However, land-use planning is in general terms handicapped by the fragmentation and overlapping of the institutions involved.

The Deputy Commissioner may sell sites for building, as long as 18% are reserved for lower castes, for a price which is not lower (except in especially deserving cases) than the market price. These sites cannot be granted to people who already own a home or land within the village, or have received a site from the authority in the last 20 years. Although the government has introduced policies and programmes designed to provide plots to poor people, these have not typically reached the poorest of the poor. In addition to this, the Town Planning Department lacks the capacity to keep an updated cadastral system. A Revised Comprehensive Plan was developed in 1998 but is likely to have similar weaknesses to the 1988 plan (Subhas, 1997; Nidagundi, 1999).

The institutional framework and policy mechanisms promoting industrial development have been characterised by Nidagundi (1999). Recently, five major industrial estates have developed around the peri-urban interface of Hubli-Dharwad for medium and small-scale industries. The Belur Industrial Growth Centre purchased 3,000 acres of agricultural land for industry. Land conversion from agriculture to industry is made by the Deputy Commissioner and the Joint Director of the District Industrial Centre (DIC), who surveys public opinion and then brings the proposal before the Committee made up of the DIC, Pollution Control Board and HDUDA, with the District Commissioner as chairman. In consultation with the District Commissioner, the Joint Director of the DIC has the authority to authorise the conversion of agricultural plots of land of less than two acres to industrial use. Tax concessions have been one of the main mechanisms deployed by the State to attract new industries, aiming to relieve pressure on the Metropolitan area of Bangalore (University of Birmingham *et al*, 1998a, p.106).

Compensation given to farmers is negotiable and is double that fixed by the Registrar of Land Records. There is no obligation on the part of the industry to offer employment to those displaced from the land. This policy has encouraged many agricultural landowners to offer their lands for conversion in order to profit from the compensation. A major gap appears in understanding the coping strategies adopted by farmers to compensate for the loss of their farmland when it is sold.

The Baseline Study found that information on land holding is available in each village going back several decades (University of Birmingham *et al,* 1998a, Section 8.4; 1998b, 1998c). The Revenue Department keeps manual records and maps of land holding for each village. The creation of a computer database and related digital maps covering those villages where land pressure appears to be more acute could facilitate the analysis of land transactions and values, providing a useful tool to monitor changes taking place in the peri-urban areas of the city region.

Another trend to be considered in the analysis of changes in peri-urban areas driven by urban development is the increasing amount of urban waste flows. The peri-urban interface is the chosen location for the cities' landfills, where waste pickers operate (despite the fact that most of the glass and plastic is separated out of urban solid waste for resale before the waste reaches the dumpsite). Some urban waste is composted and used as fertiliser on agricultural land, although this mechanism is largely restricted to wealthy farmers who can transport the waste from the dumpsites and hire labourers to separate the waste before application to the fields. There is possible contamination of groundwater from landfills (University of Agricultural Sciences *et al.*, 1997).

The Health Department of the Hubli-Dharwad Municipal Corporation (HDMC) has responsibility for the collection and disposal of solid waste. It is estimated that around 50 tons of solid waste are collected in Dharwad each day and around 120 tons per day in Hubli. Each city has a dumpsite, though the HDMC is seeking to relocate the Dharwad dumpsite as the city has engulfed the present site (University of Birmingham *et al*., 1998a).

The responsibilities of the HDMC regarding waste and sewage are set out in the 1976 Karnataka Municipal Corporations Act. The waste and sewage disposal section of the Health Department uses a fleet of 17 trucks to transport the waste, five in Dharwad and 12 in Hubli. Of these, four trucks in Dharwad and eight in Hubli are hired at the rate of Rs.350 per day. Densely populated wards, vegetable markets and slums are visited once a day, while other wards are visited once or twice a week. However, not all of the waste is collected in Hubli-Dharwad. Five private sector companies are contracted to provide municipal waste collection and HDMC has put the waste treatment facilities out to tender (University of Birmingham *et al*., 1998a).

Open dumping is the common method for waste disposal. The waste deposited at dump sites is generally neither spread nor compacted on a regular basis. It is also not covered with inert material, thus giving rise to very unhygienic conditions. Most households, shops, establishments, building contractors etc. do not use dustbins, but dump waste on streets. Hospital waste management is grossly neglected: hospitals generally do not segregate infectious and non-infectious waste, but leave all for the corporation to take to the dump site (Nidagundi,1999).

By law, local government authorities must arrange for road-sweeping and the disposal of solid waste, but this is not carried out effectively. There is a gap in the legislation as it neither makes it mandatory for residents to have a domestic bin and community bin and to dispose of their wastes into municipal systems, nor does make it compulsory for the urban local bodies to make doorstep collection of wastes or community based collection, resulting in unsanitary conditions in the urban areas. The laws generally provide for street sweeping, provision of dustbins and removal of waste therefrom, which are not adequate to handle the situation effectively. They also fail to give powers to local bodies to punish the offenders. Local bodies have to file complaints in the courts where the legal process is very slow. The monetary value of fines that can be imposed is also very low, thus having little effect and leading people to blatantly disrespect the law (Nidagundi, 1999).

Industrial waste is generally disposed of in an unscientific manner which creates environmental pollution. Industrial plants lack adequate treatment facilities and state industrial waste disposal is not strictly enforced. However, the government appears to be committed to encouraging the development of industries seeking to maintain ecological and environmental balances. Distilleries are one of 18 categories of polluting industries, and the pollutants created such as solids, liquids, gaseous substance present in such concentrations of pollutants should not be damaging to the environment. Several norms for treatment and disposal of effluents from distilleries are in place. These include the use of Environmental Impact Assessment reports and Environmental Management Plan using remote sensing technology. The norms also allow composting of effluents after preliminary treatment for agricultural purposes under some circumstances (Nidagundi, 1999).

A research project (R7099) was conducted by the Universities of Birmingham and Wales, Bangor (Universities of Birmingham *et al.*, 1998a; 1998b; 1999a), which provided an initial characterisation of the main stakeholders involved in urban solid waste (USW) management and the composting of USW both from the supply and demand sides (Universities of Birmingham *et al.*, 1998a; 1999a). A number of options to optimise the use of municipal waste have been adequately characterised, focusing particularly on potential strategies for optimal composting solutions affordable by smaller per-urban farmers.

Segregation at source is hardly carried out, except for separation of recyclable materials such as paper, plastics and glass by households for sale as scrap. A number of waste picking households operate in Hubli-Dharwad, an occupation based on community and caste, and mainly comprised of women and children. All newspapers are sent for recycling, for which there is an efficient system of collection. Recyclable materials include: plastic bags, plastic bottles, paper, milk pouches, tin/metals, cardboard, most of which go to Bangalore where there are more sophisticated waste markets and can fetch between 1 and 14 rupees per kilo (University of Birmingham *et al.*, 1999a). There is some recycling activity in Hubli-Dharwad, but there is a lack of information on this. Recycling units and associated industries are also key stakeholders to reduce the non-organic content of municipal solid waste and deserve further attention.

Although sewerage networks cover most of the urban areas of Hubli and Dharwad, peri-urban areas are characterised by a lack of sanitation infrastructure. No sewage effluent is treated, and there is a tradition of reuse of urban wastewater, sewage effluent and nightsoil as fertiliser on agricultural land, with some cultivation taking place alongside sewage channels. This can pose an environmental health hazard if the effluent is not sufficiently decomposed and thus requires further investigation (University of Birmingham *et al.*, 1998b).

The flow of urban and industrial solid waste – and to a lesser extent of liquid wastes - into peri-urban areas has been identified as a source of problems and opportunities to enhance the management of natural resources, to increase the productivity of farming systems and to improve the livelihoods of small peri-urban farmers. The institutional arrangements and policy mechanisms in place to control and regulate negative impacts have also been adequately characterised. However, their effectiveness needs to be further investigated as well as the role and capacity of several of the key stakeholders identified in the management of industrial and municipal solid waste.

In summary, the impact of urban development on the use of natural resources and the livelihood strategies of peri-urban dwellers have been only partially characterised in the NRSP research done so far. When looking at the policies currently in force, conflicts appear between long established policies supporting agricultural production and the more recent emphasis on industrialisation. Urban expansion is largely portrayed as an outcome of the lack of effectiveness of urban planning institutions and mechanisms. Further research is required to understand the driving forces behind land use changes and to examine whether they are a result of poor planning capacities at the local level or an outcome of contradictory policy objectives at the state and central levels. Road construction and transport policies have not yet been explored but appear to be extremely relevant in order to understand in what direction urban expansion is likely to occur and who is gaining access to urban facilities. Overall the development of specific initiatives to articulate and strengthen the planning

capacity of urban and rural institutions appears as a key factor to control the problems and profit from the opportunities arising from urban expansion.

An overview of the peri-urban area of Kumasi

Defining the peri-urban interface

Unlike the NRSP research in Hubli-Dharwad, the baseline study for the Kumasi peri-urban interface (Holland *et al,* 1996a, p. 8) shies away from defining spatial limits for it; this is partly because spatial limits are "moving targets as the intra-urban city expands" and partly because "there is considerable economic activity that would cross any arbitrarily defined boundary", but also because environmental phenomena (e.g. water pollution) have their own spatial impact. The baseline study team selected a number of villages located at distances ranging from 4 km to 47 km of the centre of Kumasi. The main consideration for including a village as part of the peri-urban interface was "the presence of bush/fallow agricultural land, but with competition for land from non-agricultural uses" (Holland *et al,* 1996a, p. 8).

It is not clear how the 'region' might be best defined for the purposes of the NRSP research programme. One possible definition would include the Ashanti (sometimes spelled Asante) Region, of which Kumasi is the administrative capital, as well as its historic and economic centre. Although smaller than the historical area of the Ashanti Kingdom, the region acquired its present boundaries with the Local Government Administration Act of 1971 (Nkansa Buabeng, n.d), and is one of ten regions into which the country is divided for administrative purposes.

For future research activities, another definition would limit the region to the 'Kumasi peri-urban' area, which is the approach taken by KNRMP researchers. Although more arbitrary and difficult to define, and with the additional problem that this region will continue to shift in size and shape as the city expands, this is perhaps a more appropriate choice for the purposes of any future research/action projects. The criteria behind the definition of this region appear in Holland *et al* (1996a), while Blake *et al* (1997a) defines its rough boundaries as being within a radius of 40 km from Kumasi, a 'guesstimate' of the area the city is likely to exert some influence upon.

The conurbation of Kumasi comprises an area which includes the Kumasi City Council (KCC) and the four districts adjacent to it: Kwabre, Atwima-Kwanwoma, Ejisu Juaben and Atwima-Nwabiagya. Together, the five districts constitute what may be called the Greater Kumasi city region "to which … does not correspond any official administrative body" (Corubolo with Mattingly, 1999, p. 1). The most recent official information on population for the five districts is derived from the 1984 population census (Table 2.1).

Table 2.1   Population in Kumasi and adjacent districts, 1984

	Kumasi City Council Area	Kwabre	Atwima-Kwanwoma	Ejisu Juaben	Atwima Nwabiagaya
Female	103,873	15,296	9,787	9,143	10,718
Male	103,695	11,511	10,321	7,804	9,259
Total	**207,568**	**26,807**	**23,051**	**22,255**	**19,977**
Share (%)	69.3	8.9	7.7	7.4	6.7

Source: Holland *et al.* (1996a)

The regional and city economies

Future development strategies for peri-urban Kumasi ought to be based on some degree of awareness about the economic potential of both the city and regional economy. And yet, authors agree that there is a dearth of information on both. None of the documents consulted appear to provide a profile of the regional economy and only one (Korboe *et al*, 1998) provides a partial overview of the economy of the city (including its metropolitan area).

Although not an administrative entity, the Greater Kumasi city region (GKCR) would seem to be a useful unit of analysis for the purposes of the research and any subsequent strategies developed as part of the programme. However, it must be borne in mind that the peri-urban area is still a problematic concept, and that any trends are likely to be influenced by wider economic developments in the larger Ashanti region. Thus, reference should be made as far as possible to wider processes such as in-migration from the Ashanti region into Kumasi, marketing of agricultural produce and livestock to and from Kumasi and its surrounding area, substantial changes to infrastructure (e.g. transport, electricity, telecommunications), and other relevant indicators which might affect the economy and the livelihoods of the population in the GKCR.

Not much is known about long-term trends in the region's economy. For example, it is not clear how liberalisation affected the productive base, nor the long-term trends in cocoa production, an export product that for decades provided the mainstay for the region.

There is, however, some characterisation of the marketing system in and around the city (Blake *et al,* 1997a, p.86), which leads researchers to state that "the peri-urban areas are not the sole suppliers of foodstuffs to the city (but) areas beyond its daily sphere-of-influence may be able to supply produce at lower unit costs, or may have more land available, or have other comparative advantages". Furthermore, "the whole country, perhaps even the entire coastal West Africa, could be defined as the area of supply of its foodstuffs" (ibid.).

Key components of the Kumasi peri-urban region appear to have been adequately characterised in the different project documents, more notably Holland *et al* (1996a), and to a lesser extent Blake *et al* (1997a) and Kasanga (1998). But because of the nature of the KNRM project, these documents have tended to focus on the natural resource-based economy, notably agriculture, livestock, mining, energy, land, water and waste. Little or no attention appears to have been paid to non-natural-resource sources of sustainable livelihoods that are appearing or rapidly changing, such as trade, construction, small-scale and medium-sized manufacturing, services (e.g. repair workshops, hairdressers), as well as elements providing important support to the regional economy such as the regional infrastructure (e.g. electricity generation and distribution, other sources of energy, roads, telecommunications), education, health and inter-regional transport (there is some information, however, on intra-regional transport particularly to and from Kumasi). Similarly, there is no reliable picture of the changing composition of the labour force: the last source of information which might provide a composite picture of this is the 1984 national population census, whose reliability has been disputed (Korboe *et al*, 1998).

Some of the trends in the peri-urban economy may be gleaned from the reports. Tables 2.2 and 2.3 provide a summary of how these have affected a range of villages selected by a team led by Kasanga in 1996 (Kasanga, 1998, 1999). The trends reported there are corroborated for another set of peri-urban villages reported in Blake *et al* (1997a)[1]

The data in Table 2.4 show clearly that all peri-urban villages grew in population between 1984 and 1996, with the exception of Behenease, the most distant village, located some 24 km from the city centre. All except two expanded at higher rates than the national population growth estimated at some 3% per annum. This suggests that they are net recipients of population. Although according to respondents these villages have also 'exported' some of their former residents (in proportions ranging from a low of 5% in Atasamanso to a high of 37% in Akokoamong), they have been also giving shelter to newcomers.

Table 2.2 Share of labour force in agriculture in selected peri-urban villages around Kumasi, 1970-1996

Village (approximate. distance to Kumasi centre)	Share of labour force in agriculture* (%)						
	Female				Male		
	1970	1984	1996		1970	1984	1996
Akokoamong (13km)	56.3	55.8	30		32.2	30.6	28
Asaago (12 km)	49.5	49.6	41		40.0	41.0	32
Atasamanso (7 km)	33.1	29.2	6		20.0	18.1	4
Behenease (24 km)	38.5	41.2	54		41.5	40.1	36
Emena (13 km)	60.8	60.1	24		20.6	25.7	16
Esereso (13 km)	47.5	45.2	14		35.0	34.5	8
Maase (13 km)	59.1	58.7	34		19.3	22.3	20
Okyerekrom (15 km)	38.1	36.8	27		18.4	17.2	21
Mean	47.9	47.1	28.8		28.4	28.7	20.6

* For 1970 and 1984, the national population census uses the classification 'agriculture'; the 1996 census conducted specifically for the research uses the classification 'farming'.
Source: Kasanga (1998, table 5 and appendix 2)

Table 2.3 Share of employment in selected occupations in Kumasi and adjacent districts, 1984 (%)

	Kumasi City Council	Kwabre	Atwima-Kwanwoma	Ejisu Juaben	Atwima Nwabiagaya
Agriculture	12.3	66.2	84.2	74.5	76.2
Manufacturing	20.9	11.1	4.3	9.6	8.1
Trade & restaurants	41.9	13.5	5.3	7.5	8.5
Community social services	25.0	9.2	6.3	8.3	7.2
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
Total employment	**186,830**	**25,567**	**22,408**	**21,665**	**19,065**
Share in GK (%)*	67.8	9.3	8.1	7.9	6.9

* District share of Greater Kumasi in the four occupations shown
Source: Holland *et al.* (1996a)

Table 2.4   Population growth in selected peri-urban villages around Kumasi, 1970-1996

Village (approximate distance to Kumasi centre)	Resident population				Native population	
	1970	1984	1996		1996	
			Total population	Annual growth* (%)	Currently Resident (%)	Out-migrant (%)
Akokoamong (13km)	247	322	488	3.5	63	37
Asaago (12 km)	273	527	847	4.0	82	18
Atasamanso (7 km)	830	971	2,679	8.8	95	5
Behenease (24 km)	207	274	258	-0.1	67	33
Emena (13 km)	213	244	665	8.7	81	19
Esereso (13 km)	441	673	1,711	8.1	90	10
Maase (13 km)	269	522	829	3.9	69	31
Okyerekrom (15 km)	497	589	734	1.9	68	32

* Annual growth of village population between 1984 and 1996.

Source: Kasanga (1998, Table 3)

The survey reported in Adam *et al.* (1997, p.4) comprises six villages located between 8 and 30 km of Kumasi city centre, of which only two are located on a main tar road. Data for these also suggest that four or five of these villages experienced net growth between 1984 and 1997, while one or possibly two had decreases due to out-migration exceeding in-migration. In-migrants to these villages came mainly from the north of the country. "While in-migration has been either for farming or in the case of Abuakwa (and Duasi) for easy commuting access to the city, out-migration has in most cases been to the city (or perhaps one of the settlements closer to the city) to seek or engage in urban occupations" .

The reasons why peri-urban villages closer to the city attract newcomers are mentioned by Kasanga (1998), and would seem at least partly to relate to the higher costs of housing in Kumasi. Housing rental in Kumasi tends to be expensive for the poor, who often live in overcrowded conditions in large compounds accommodating several households; only the better off can build and own detached villas, both in town and in its surrounding area (Tipple, 1998). A substantial number among poor owners and renters use their dwelling for generating income from a range of activities including food production, manufactures, shops, and services, such as hairdressing and day care (Sinai, 1998).

It is pointed out in Holland *et al* (1996a, p.18) that "many of the new villas being built in and around Kumasi belong to strangers rather than local villagers". Although some anecdotal evidence may be available, this may in fact be an unsupported generalisation which contradicts the findings of Tipple (1998) for Kumasi, who in a sample of 184 house owners who had recently built their house found that the average length of stay of the household head in the city was 29 years (with a median of 25). Their average age was 48 years, while on average the new house to which they had moved in had 6.3 rooms.

Holland *et al.* (1996a) also states that recent in-migrants are said to work in the city, "or at least have income sources from outside the village" (ibid.). However, the research does not seem to have focused on the group of in-migrants to these villages, so not much is known about them. A more in-depth and systematic analysis of a sample might have provided more information on the reasons why they chose to move to the villages, their sources of income, their age and sex breakdown, their skills and so on. Even a non-statistically representative sample of the peri-urban area might have provided some clues about the current and potential role that peri-urban villages provide particularly as regards newcomers (be they from the city or from outside the region). It might have also provided some idea about their desire to settle in the peri-urban area, thus giving some clues about possible future trends.

Similarly, not much seems to be known about middle- or upper-income purchasers of land in the peri-urban area, nor about their intentions to permanently settle in the area. There is some anecdotal evidence that as the ancestral seat of the Asantehene, Kumasi may attract people of Ashanti origin who seek to settle in the area (Blake *et al.* 1997a). Others may in fact be simply using their savings (from Ghana or abroad) to speculate with land in and around a city that is growing fast and where urban land prices may also be rising fast. Some more systematic knowledge of this might be relevant in forecasting future trends in sales of peri-urban lands for housing and related amenities (commercial uses, clubs) and perhaps even businesses that do not require a central location to operate. Moreover, as will be shown later, this might also provide some clues as to the

pressure they are likely to exert in attracting utilities to the area, and even in accelerating the pace of gentrification in the villages.

As has been shown in the project documents, the labour force in peri-urban Kumasi is fast ceasing to depend on agriculture. Data for 1996 show considerable drops in the proportions working in agriculture in the eight villages surveyed by Kasanga compared to the previous two decades (Table 2.2). In some cases, such as Akokoamong, Emena and Maase, from employing more than half the female labour force, this had dropped to between a third and a quarter. Only in the most remote village, Behenease, was there an increase in the share of female labour force in agriculture between 1984 and 1996. As has been shown in the project reports, agriculture employs a proportionately smaller share of men, but even here there were marked drops in virtually every case, with the exception of Okyerekrom (the second most distant village).

The data from the six villages surveyed for Blake *et al.* (1997a, p.5) show similar trends, with agriculture still the main source of livelihood but ceasing to be a primary occupation particularly among young women and men. It is, instead, acquiring a secondary and supporting role. The young (especially men) "are generally not interested in traditional food crop farming, but if they remain in the village become engaged in crafts and artisanal work, also vegetables and rice growing". By the same token, "opportunities for alternative livelihoods within the village for women are restricted to trading, crop and food processing, dressmaking and hairdressing" (ibid.).

The figures in Table 2.3 point to a long-term trend, similar to one observed in metropolitan regions around the developing world, towards forms of employment other than primary sector activities. And although some pointers are provided in the project reports, there is, however, no composite picture of what might be appearing as other possible sources of employment among the peri-urban population. We do know, however, that 'unemployment' is high there (Kasanga, 1998, 1999), though it is not clear from the data how, in the absence of a social security system, the unemployed survive without sources of income. One suspects that extended family networks provide a form of safety net but not much is known about how this operates and how long it is likely to be effective in sustaining the livelihoods of the unemployed (see chapter 6 for a more detailed discussion on peri-urban livelihoods).Given the trends described above, and the continuous physical expansion of the city towards its periphery, one might expect peri-urban inhabitants to shift towards occupations in the secondary and especially tertiary sectors. However, what other possible sources of income for the peri-urban poor there might be in this context is not clear either. Some clues might be

provided by an examination of the city economy, and an assessment of the main trends.

A 1984 snapshot view of the distribution of employment in Kumasi and the four adjacent districts is given in Table 2.4. This shows that the area of jurisdiction of the Kumasi City Council (KCC) had the lion's share for Greater Kumasi of employment in the four selected employment occupations shown in the table (this does not include all forms of employment). Even in agriculture, the KCC had more jobs than any of the other districts, though not surprisingly the relative share of agricultural employment was considerably smaller than in any other district shown. In terms of non-agricultural employment, Kwabre District was more active than any of the other adjacent districts in manufacturing, trade (including restaurants) and services. It is interesting to note that already in 1984 in all four districts there was a non-negligible presence of non-agricultural activities, a sign of the dispersal of jobs and residents from the city core that these districts was already experiencing.

Although focusing on governance and urban poverty, the economy of contemporary metropolitan Kumasi has been partially characterised in a report produced for DFID by Korboe *et al* (1998). They do note that availability of reliable information is also a problem in the city, which leads them to shy away from making an assessment of trends in key economic activities (Korboe *et al*, 1998, p. 16). They do, however, list a set of key factors that appear to have supported growth in the city's economy in the last decade. Most are at least partly the result of central government measures, such as:

- Liberalisation of trade, price de-regulation and relaxation of foreign exchange controls. This has helped attract remittances from nationals working abroad.

- Linked to the above is that competition in the banking sector has made banks more reliable to local savers

- Central government promotion of international tourism, which has helped attract US and Caribbean African descendants. Tourism is the fastest growing sector in the national economy, and Kumasi is an important recipient of tourists. It is estimated that half of all tourists arriving in Ghana visit Kumasi. However, no figures are offered on the employment this generates, or the income this brings to the city.

- Establishment by the central government of the Land Valuation Board. This led to a revaluation of the city's properties and to substantially increased revenues for the Kumasi Metropolitan Assembly (KMA).

- Improvements in KMA's finances through the District Assemblies' Common Fund, resulting in a doubling of KMA revenues.

    Other measures have been specifically targeted at Kumasi:

- Central government investment in telecommunications and its subsequent privatisation. This dramatically increased the number of telephone lines especially in central areas.

- Improvements in infrastructure, mainly roads and water supply (with funding from the World Bank and DFID, among others). This opened up certain areas of the city to light industry, commerce and services such as car repair workshops (though it is not clear whether some of these were peri-urban in nature).

Some of the above have also had a negative impact on the city's economy, as is the case of import liberalisation. The authors argue that local manufacturers, "burdened with obsolete equipment and frequent breakdowns, have been extremely distraught" about its effects on their businesses (Korboe *et al*, 1998, p. 12). "A flood of imported second-hand clothing has been blamed for the declining patronage in the local textile dyeing, clothes-making and leather-working industries". Moreover, they argue that "it is apparent that the city's economy is driven primarily by imports and not by local production", though not much evidence is shown to support this proposition.

Another constraint on the city economy, also gleaned for peri-urban activities from some KNRM reports, is the high cost of informal credit (with interest rates of up to 15% per month against 50% APR for bank loans) and the barriers to entry into formal credit for the poor in the form of stringent demands for collateral. Another possible constraint to the growth of the local economy may come from an impending sharp increase in electricity tariffs and re-imposition of VAT at some date after the report was written. These apparently caused apprehension among businesses, but the authors fail to make any specific forecasts about their possible effects.

However, despite these useful pointers, the report lacks a systematic analysis of the economy of the metropolitan area. There is no attempt to identify the economy's growth sectors, sectors linked to exports, and how these might be promoted to maximise economic growth and employment. Similarly, there is no breakdown of the city's employment into its different sectors, and there does not seem to be an attempt to for example identify those sectors that might be supported by different institutions so as to increase incomes among the poor and most vulnerable groups.

An important dimension of the local economy that is highlighted in the report is the financial and operational capacity of local institutions, notably the Kumasi Metropolitan Assembly. This is shown to be structurally weak and poorly managed. "The main areas of weakness in KMA's revenue management would appear to be low rate levels, unscientific revenue forecasting, under-collection and non-monitoring of collections. Ultimately, shortfalls in revenue collection are likely to impact in KMA's ability to finance needed growth-promoting services" (Korboe *et al*, 1998, p. 14).

The institutional landscape

Institutional structures that impinge upon sustainable livelihoods comprise state institutions, traditional government structures, the private sector and non-governmental organisations, including community organisations. When it comes to analysing the role played by governments and their relationship to the private sector and local communities, the concept of governance can help advance our perception of what is relevant in this respect. In the case of Anglophone West Africa, Onibokun (1996, p. 168) has claimed that:

> Urban poverty is exacerbated by managerial incompetence, inefficiency, ineffectiveness and unresponsiveness. Moreover, a lack of transparency, accountability, responsiveness, institutional legitimacy and popular participation, have combined to weaken the capacity of the state. Few states are able to face the challenges of urban growth effectively. However, the solution seems to be in the institutionalisation of good governance. Simply stated, current practices cannot lead to sustainable development … the partnership between government and civil society is a mirage.

Governance has been defined by McCarney, Halfani and Rodriguez as "the relationship between civil society and the state, between rulers and the ruled, the government and the governed" (quoted in McCarney, 1996, p. 4). Local governance comprises "the operations of local governments, their relationships with the societies within which they operate, and ... the technical area of 'urban management'" (UNCHS, 1996).

Traditional and state structures

Government institutions in Ghana can be divided into national, regional and district (Nkansa Buabeng, n.d). In general terms, the existing literature provides useful and fairly thorough characterisations of these and of the recent changes to have affected them. A useful summary overview is provided in the form of an organisational chart in Appendix VII of Holland *et al.,* 1996b. This shows the Judicial, Legislative, Executive and Traditional structures of government at the national, regional, district and town/village levels in the mid-1990s (though a proviso is made in the document regarding the chart not being "an authoritative account of the structure of Government"). The same document provides a list of ministries and government departments, and their corresponding institutions at the national, regional and local levels, as well as an outline of institutions in all government tiers with responsibilities in managing natural resources. Although useful, it is worth pointing out that any future efforts to use this information should as far as possible be updated and checked with knowledgeable individuals.

It must be stressed that in Ghana formal government institutions cannot be dissociated from traditional governance structures. This is still true in urban and peri-urban Kumasi, particularly when compared with Accra where a much larger and diverse population, aided by Accra's more diversified economy, has contributed to a greater weakening of traditional structures (Gough, 1999).

A number of reports and documents produced by the research project provide an overview of social structures in the Ashanti Region. As has been shown in the section on land in this report, an understanding of traditional structures of government, particularly as they affect land tenure and land use, is important for the adequate formulation of future policies and strategies regarding peri-urban land. The Kumasi Peri-urban Baseline Studies report (Holland *et al.,* 1996b), the Inception Report (Blake *et al,* 1997a, pp.15-29), and two papers by Kasanga (1998, pp.23-33, 1999) provide useful overviews of traditional social structures in Kumasi and its peri-urban area, and highlight the effects they have on the changing use and ownership of land and other natural resources.

In villages, a distinction is made between family land (each family clan has its own land), stool land (land not allocated to specific families and controlled by the chief, who can sell it for development), individual lands (lands already sold by the chiefs), and government lands (used for public facilities). Apart from the implications of the sale of village lands (stool lands) in terms of homelessness and landlessness suggested under the sustainable livelihoods section, it is also pertinent to examine how the money from these sales is used locally to further

development and help the poor. This has been explored in the sub-section on Land.

The documents also produce a characterisation of the relationship between the state and traditional authorities. The Baseline Study (Holland *et al.,* 1996a, p.18), for example, says that "the Lands Commission, which is responsible for the management of government lands, recognises the role of the Traditional Authorities in that it only accepts sale of lands which have been agreed through the established traditional channels". Thus, it acts "in support of the established

Decentralisation in Ghana

Decentralisation has been an important feature in Ghana's recent history. Accounts of its main features may be found in Nkansa Buabeng (n.d), Gough (1999) and Onibokun (1996). Gough notes that the Rawlings' PNDC government introduced the decentralisation programme, for which the district assemblies are the basic unit, "partly to placate the World Bank which was demanding fiscal accountability across state institutions and good governance including democratic elements. The PNDC was also facing internal critique from workers and students over the austerity brought about by structural adjustment and needed a strategy to placate these pressures and avoid a legitimacy crisis" (Gough, 1999, p. 8). Figure 1 in Nkansa Buabeng (n.d), provides a graphical summary of the structure of the country's decentralised system of government. For Onibokun (1996, p. 166) "decentralization has not been accompanied … by a devolution of power and authority. The various localities still operate as appendages of the central/state authorities, directed at will by the central or state institutions and depending almost entirely in their central government for their resources and initiative … all the chief executives directing the 110 district councils were appointees of the central government." Nonetheless, at least two-thirds of the assembly members are elected on a non-partisan basis, while the other third are appointed by central government.

As the overall government authority in a district, District Assemblies have an important potential role in promoting development and supporting the livelihoods of the poorer and more vulnerable members of their community (Holland *et al,* 1996b; Gough, 1999). They are mainly responsible for the overall development of the district, including the formulation of a plan and budget, and they implement development policies and programmes co-ordinated by the National Development Planning Commission (Nkansa Buabeng, n.d).

Under the Local Government Act 1993, Assemblies have deliberative, legislative and executive functions (listed in Holland *et al,* 1996b, p. 82). In theory at least, they are the highest political, administrative and planning authority at the district level. Many of their functions relate to provision of local services. In metropolitan areas like Kumasi, they are called Metropolitan Assemblies. In addition to the Kumasi Metropolitan Assembly, Kumasi has four Sub-metropolitan District Councils with executive functions.

In performing the executive and administrative functions, District Assemblies rely on a committee system which assigns specialised functions to the Executive Committee (called Metropolitan Authority in the case of Metropolitan Assemblies) and a range of sub-committees, whose number and functions vary according to the size and location of the district. Each sub-committee is comprised of a number of Assembly members as determined by the Assembly. Heads or representatives of government agencies are in theory expected to attend meetings of relevant sub-committees as ex-officio members with no voting rights. Sub-committees carry out detailed studies and other work in their area of concern, thus relieving the Executive Committee from these. A list of sub-committees in the five districts within the GKCR as well as the functions of the different sub-committees is found in Nkansa Buabeng (n.d). As the case of Kumasi suggests, by virtue of their larger size and greater complexity, Metropolitan Assemblies have a larger number of sub-committees covering a wider set of functions.

Within each district there are a number of Unit Committees at the village level (normally settlements or groups of settlements with populations between 500 and 1,000 in rural areas, and up to 1,500 in urban areas). This is the lowest level of the administrative spectrum. Unit Committees have important functions in "education, organisation of communal labour, revenue raising and ensuring environmental cleanliness, registration of births and deaths, implementation and monitoring of self-help projects" (Holland *et al.,* 1996b, p: 83). Within Kumasi Metropolitan Assembly there are 403 Unit Committees, while in the four adjacent districts they range in number between 64 and 216. The functions of these committees are also enumerated in Nkansa Buabeng (n.d) . Although they have no explicit planning or environmental protection functions, in practice, they "are concerned with development planning functions at the village level. This is because project initiation starts at the village level" (ibid., p. 12).

Natural resource planning and support for regional development

In the context of the NRSP, an adequate understanding of the structures of government nationally and in the Kumasi city region becomes necessary insofar as they have a bearing on the formulation of future strategies for interventions in land use and natural resources-based production systems. In that sense, it may be argued that one need look no further than to those institutional structures that directly or indirectly affect the use of such production systems. The most obvious one relates to those institutions that play a role in planning the use of natural resources in peri-urban Kumasi, including land. A brief review of the planning systems in operation is included elsewhere in this chapter.

It was already argued that the use of peri-urban natural resources cannot be dissociated from trends in the use of other resources in the Kumasi city region. This is so because it is very likely that, given recent trends, a diminishing proportion of the peri-urban population of the city will continue to make a living from the natural resource base, including land. So, future strategies regarding land use must look at alternative uses of peri-urban and urban land that provide alternative sources of income to the peri-urban and urban poor.

If this proposition is accepted, one must therefore look for studies that provide an adequate characterisation of government institutions which are in a position to support future income-generating activities of a non-primary nature. In that sense, the research by Korboe *et al (*1998, p.7) provides some useful pointers. These authors identify the Kumasi Metropolitan Assembly (KMA) as a key player in helping to guide future developments, though its actions are restricted to a small range of activities: providing and managing latrines, "compulsorily acquire any lands necessary for the nation's development", provision of business credit, provision of basic health and education services, and disaster management. The extent to which the KMA is active in these is briefly explored in the sub-section on Processes.

Other government institutions whose role might be explored in this respect include:

- District Assemblies: it was said earlier that Assemblies play an important role in supporting local development. However, existing research does not seem to explore sufficiently the issue of their recent performance and their real capacity to effect change. In particular, more evidence seems to be needed in terms of their potential capacity to channel funds from the sale of land towards improvements in local services which might help support livelihoods especially among the peri-urban poor (see section on Land).

- Unit Committees: these are the smallest administrative unit, for they operate at   the   village   level.

- National institutions providing credit to businesses in the peri-urban area such as the National Board for Small Scale Industries (Korboe *et al*, 1998, p. 18)
- The National Disaster Management Organisation (NADMO) which is supposed to focus on disaster prevention mainly through education on environmental sanitation, though in practice very little is done other than provide token levels of relief (Korboe *et al*, 1998); in Kumasi there have been recent cases of flooding due to man-made blockages to the natural watercourses (through construction and indiscriminate disposal of refuse in drains and elsewhere) and fires resulting mainly from illegal and sub-standard electrical connections.

There are a number of non-government institutions which may provide some assistance to peri-urban dwellers in Kumasi. One of these is the Association of Ghanaian Industries (AGI) which is "expected to manage funds intended for disbursement as small credits" (Korboe *et al*, 1998, p. 18). The spectrum of community based organisations (CBOs) found in peri-urban communities is described in Pender (n.d). These typically have small memberships and range from religious associations to a youth group linked to the governing party. Their scale of operations is modest and they are funded largely through membership fees and most remain local, with little if any links to local organisations (other than the Unit Committees in a few cases), let alone organisations outside the region or Ghana. An interesting finding of the report is that the functions of these CBOs tends to focus on welfare issues in the more urbanised villages and on agricultural production and distribution in the more rural villages.

Land-use planning and the peri-urban interface

There is little planning (physical or economic) effective enough to have a role in major peri-urban production systems. There are no broad strategic plans covering the peri-urban area, much less ones which cover both peri-urban and urban areas (Blake *et al*., 1997a, p. 111).

Although there are actions stated in the development plans for the three peri-urban districts of Kumasi which would affect major production systems in the peri-urban interface, there is no evidence that these have been or are being implemented. Much less is there knowledge of their effects (Kasanga, 1999). From a 'review' of district development plans for three peri-urban districts around Kumasi (Williams, n.d.), it is possible to deduce that:

- A good deal of technique is available to the governments of these districts;
- There is machinery operating to produce plans of this kind;
- Much is known about the facilities in these districts;

- There is no recognition of the changes being caused or to be caused by the presence and growth of Kumasi, neither opportunities or threats. Problems and benefits do not seem to be recognised (there are one or two references to markets in Kumasi) and plans do not reflect the influences of, or any linkages to, Kumasi.

One district plan (Kwabre's) does recognise proximity to Kumasi as an important feature of potentials and restraints, but does not seem to respond to this at all with its plans. In short, there is little if any acknowledgement of the peri-urban interface effect and no attempt to address its opportunities and problems. In any case, district development plans have not attempted to address problems and constraints with specific proposals (Holland *et al*., 1996b, p. 31).

Some implementation of physical planning does take place in peri-urban Kumasi. A chief says he does not make allocations of land except those shown on the approved planning layout (Holland *et al*., 1996b, pp. 34, 41). But in another village, there is illegal housing in poorly drained areas (ibid., pp. 25-26, 34).

Planning for the Kumasi Metropolitan Assembly area as it expands into the peri-urban interface obviously affects production systems there when it is implemented, but this is estimated to happen in only 30% of the cases of layouts for developing land for urban purposes (Holland *et al*., 1996b, p. 26).Planning schemes do not incorporate agricultural zones (ibid., p. 32).

Planning is also said to be handicapped by lack of information, especially about which villages are growing and which have potentials. At the same time, no strategic planning is taking place which affects either Kumasi or its peri-urban interface (Holland *et al*., 1996b, p. 31).

The principal stakeholders in the planning of the peri-urban interface are known, as are those responsible for their implementation. For example, the district assemblies are responsible for preparing and implementing the district development plans (Holland *et al*., 1996b, p.24). Some of these are recorded in the literature (Holland *et al*., 1996b; Blake *et al*., 1997a; Williams, n.d.), but this is not a matter for research as they seem to be generally known locally. It is known that they do not cooperate and coordinate well (Blake *et al*., 1997a, pp.68, 77). Similarly, planning coordination among villages is weak (Holland *et al*., 1996b, p.31). The behaviour of various stakeholders and actors which leads to poor implementation of planning which affects the peri-urban interface does not appear to　　　　　　　　　be　　　　　　　　　documented.

Decision-making processes

In the sustainable livelihoods framework proposed by DFID (Carney, 1998a), the notion of 'processes' relates to the policies, laws, rules of the game and incentives which help define people's livelihood options. An adequate characterisation of these must relate to the structures defined earlier and therefore include an overview of the real and potential actions that may be taken by a range of actors at the national, regional and local levels. Any future research and intervention strategies within the NRSP must be framed within existing policies and if possible even foresee, and adapt to, subsequent changes in policies that might jeopardise the intended goal.

Cultural factors

In an examination of the range of factors that have led to environmental deterioration in peri-urban Accra, Yankson and Gough (2000, p.6) have identified the advance of Christianity over traditional beliefs as having accelerated the deforestation of what used to be regarded as sacred groves. "In the past, all of the indigenous villages had several sacred groves where they had their fetish shrines. People were not allowed to enter the groves hence the vegetation was left untouched. These taboos served as a means by which the traditional societies conserved their environmental resources. Today, however, only a few of the sacred groves are left".

The role of that cultural factors such as these does not appear to have been explored in the research reports on peri-urban Kumasi. In the absence of ethnographic material about the region, one may suppose that, as was reported for Accra, such factors might have impinged also in the conservation of some forested areas there. However, only a study which focused on these issues can shed further light on the effect the demise of traditional religious beliefs might have played in the demise of forests.

Policies

The research documents do not appear to explicitly cover the effect of different government policies on Kumasi's peri-urban interface. For the purposes of an analysis of their impact on the peri-urban interface, one may differentiate between those policies that have an explicit spatial dimension and those that do not (Dávila *et al*., 1999). Although some discussions may be found in the KNRMP documents about the effects of decentralisation reforms on land tenure (cf. Kasanga, 1999), and some mention is made of the possible effects of liberalisation on Kumasi's industries in Korboe *et al* (1998), there does not seem

to be a systematic attempt at tackling the possible effects of major policy shifts upon the regional or the city economy, and how sectors of their economy might be affected by such shifts. For example, not much is known about agricultural pricing or incentive policies, and how these might discourage certain types of cash crops (such as cocoa). Similarly, not much is known about trade or tourism policies that might positively influence the future development of Kumasi by strengthening some of its productive sectors.

Local/regional financing of infrastructure and development

Revenues from village stool land sales do not pass through the state system. "The local district in which the land is situated plays no part in handling land sales, but does receive revenue from the ground rents of developed areas" (Blake *et al,* 1997a*,* p. 19). Of the revenue from land sales, only a quarter is estimated to accrue to the village for provision of electricity, schools and sanitation (ibid, p.24).

More research might be needed in identifying the potential role that District Assemblies play in channelling funds from local land sales towards improvements in service provision locally. This problem is by no means restricted to Kumasi, as Gough (1999) has shown for districts in peri-urban Accra. There, an Assembly such as that of Ga District "has not been able to reach an agreement concerning the collection of development levies from stools and families who sell plots in the district, which could provide an important source of funding for service provision" (ibid, p. 9). Even in Accra, central government agencies are unable to keep up with demands for service provision in peri-urban areas, preferring to concentrate resources in inner city areas.

Similarly, more research might be needed into the reasons behind the reluctance of chiefs to use part of the proceeds of the sale of lands to fund the installation of basic services in peri-urban areas. In Ashale Botwe and Agbogba, two peri-urban districts in Accra, for example, profits from land sales have been used to improve the roads and school, and connect the villages to the electricity network. But such improvements are altogether absent in other districts like La Bawaleshie and Pantang, for example. "One factor which emerged as being of vital importance in explaining these differences, is the differing degree of control which the chiefs of the indigenous villages have over the sale of their land and hence the use of the profits derived from the sales. Where the chief or land owning family is resident outside of the indigenous village, as was the case in La Bawaleshie and Pantang, the village often derives virtually no benefit from the sale of their community land. If the village leadership is resident, enlightened, and

development oriented, as in Gbawe, then the inhabitants can benefit clearly from the land sales" (Gough, 1999, p. 10).

In the peri-urban areas of both Accra and Kumasi Assembly members have become more instrumental in improving services in the communities they represent. Gough (1999) reports that in the indigenous settlements around Accra many inhabitants regard these members as the people responsible for solving their practical problems. In Kumasi, the chiefs still play that role, though this may be undermined as the city expands and newcomers arrive and local villagers increasingly commute to the city. However, Assembly members must have the endorsement of local chiefs to hold meetings with the inhabitants of indigenous villages.

Gough also notes that residents associations are an important factor in providing basic services to peri-urban areas in Accra. Here too there might be lessons to be learned for Kumasi, and perhaps there might be some pointers here for what the future may bring and what might be the focus of future research. As most of the new home owners in peri-urban Accra are upper or middle-income households, they seek to protect their investment by forming associations that "have adopted a town-planning role to ensure that both the owners of the land and the land acquirers obey zoning regulations; they attempt to ensure that no-one builds in spaces earmarked for roads or communal areas and that the chiefs do not sell plots designated for these uses … (they) also police their areas to improve security and reduce theft, act collectively when trying to obtain documents, and arrange social functions" (Gough, 1999, p. 12). Although no evidence of such associations is apparent from the research on Kumasi, it is not inconceivable that similar organisations may develop as the city expands and peri-urban lands are taken over by greater numbers of middle- and upper-income residents.

This might have implications for low-income village residents, as the process of gentrification and the lobbying capacity of future resident associations may contribute to displacing them further out towards other peri-urban villages thus increasing the time and money they spend commuting to the city. Yet another dimension of this trend that Gough has noted for peri-urban Accra is that, once they have acquired their plot of land from the chief, middle- and upper-income arrivals have only sporadic contact with the chief, and tend to have little contact with, and confidence on, the District Assembly: "many of the new land acquirers did not vote in the district assembly elections and do not even know who their assembly member is". Moreover, "they do not consider the assembly members to be either interested in, or capable of solving, their problems, but

prefer to go directly to the district assembly themselves or to the relevant service agency" (Gough, 1999, p. 11).

In Kumasi, the functions performed by a sample of community based organisations (CBOs) in peri-urban villages are characterised in a report by Pender (n.d) . In most villages there is a Unit Committee formed in recent years to take over the role of the previous Town Development Committees. "They form the base structure of the new local government system" and their specific objectives are as stated earlier (Holland *et al*., 1996b, p.83).

Apart from Unit Committees there are other kinds of community organisations in peri-urban villages. Their main function is to protect the interests of their members, who pay membership fees or make contributions in kind. The aims of these associations vary between villages but in general terms the closer the village to the city, the more the association is likely to focus on welfare and development issues. Associations in the more agricultural settlements focus on improvements to farming, while in the more urbanised ones they act as pressure groups to enforce land use planning regulations, improve sanitary conditions, or protect members' property. A few of the organisations reviewed in Pender (n.d) are religious associations (including Christian groups) with aims ranging from spiritual advancement to improvements in welfare of its members.

In Duase, for example, a village located 8 km from Kumasi, a watchdog committee was formed in 1998 to protect lives and property around the community. The committee is comprised of 17 members, all men under the age of 40 except for a group of five elderly male coordinators, to organise night surveillance against thieves. In Apatrapa, the eight-member Health Association inspects sanitary conditions within the homes and their surrounding areas and offers advice on keeping the environment clean. In the words of the author(s) of the report, proximity to the city is perceived as bringing about burglary and unsanitary conditions, which are labelled "social vices of urbanization" (Pender, n.d , p. 31).

Although clearly not as effective or powerful of the middle-class equivalent found in peri-urban Accra, these local associations could in future contribute to improvements in living conditions in villages, particularly among the more vulnerable groups, especially if they are given access to information and training as argued by the author(s) of report (ibid).

The KMA and local development

The functions of the KMA include providing and managing latrines, "compulsorily acquire any lands necessary for the nation's development" (Pender, n.d, p. 17), provision of business credit, provision of basic health and education services, and disaster management. local government including local finances, infrastructure and services, housing and the financial market. Some of these areas were addressed directly or indirectly under KNRM but may need to be updated or looked at more in-depth in future stages of the NRSP programme.

A concluding note on planning and the peri-urban interface

The foregoing review suggests that the planning machinery and the stakeholders and actors are probably adequately known both in Kumasi and Hubli-Dharwad. Written documentation may already exist about many aspects of these, but some effort may be needed to document what is knowledge generally available to actors who are close to these processes in the two localities.

Although in both Kumasi and Hubli-Dharwad, the effects of planning for urban development on peri-urban interface production systems are not known, they are likely to be of no importance because planning in general (whether physical or economic) seems to have a negligible role in peri-urban interface natural resources production systems.

In both city-regions, the effects of planning for the peri-urban interface on livelihood strategies of the poor are not known. Consequently, the effects on those livelihood strategies of planning the peri-urban interface for urban development are also not known. Nevertheless, since so little planning for urban development has a role in peri-urban interface natural resource production, and so little planning of any kind is actually implemented, the effects on livelihood strategies are probably negligible.

From this, and for the purposes of future intervention strategies, one can conclude that there is enough existing knowledge to consider the use of planning mechanisms in both city-regions for interventions. However, it is not at all clear why planning is so ineffective. Rather than undertake investigations into the poor performance of planning and to overcome the impossibility of learning about effects on livelihoods of planning that is not felt, it would make more sense to increase knowledge of these areas through action research which would formulate strategic interventions and attempt to implement them through pilot projects.

Note

[1] There is a substantial (and as yet unexplained) difference of scale in the maps showing the location of survey villages as shown in two of the project documents. Map 1 and Table 1 in the Baseline Studies document (Holland *et al.,* 1996a) show the village of Akokoamong as being 13 km east of Kumasi's centre. However, the (un-numbered) map showing the villages in Kasanga's paper on rapid urbanisation and gender insecurity (Kasanga, 1998, p.6) shows the same village as being located some 33 km from the centre. Comparison with Map 3 in the main volume of the Inception Report (Blake *et al.,* 1997a), would seem to suggest that the smaller distances offered by Blake *et al.* (1997a) are more accurate.

3 Characteristics of major cropping systems

Cropping systems in the Hubli-Dharwad peri-urban interface

Sources of information.

In a baseline study conducted in 1997, 25 villages around the twin cities of Hubli-Dharwad were characterised by the research team, including major production systems. A few months later, four of these villages were re-visited by the team, where surveys of a more participatory nature were carried out. The "Baseline Study for Hubli-Dharwad City-Region" Project (R6825) concluded with a workshop (University of Birmingham *et al.*, 1998a, 1998b). During the course of the subsequent project, "Improved Utilisation of Urban Waste in the Hubli-Dharwad City-Region" (R7099), field work was conducted in four villages, three of which had not been visited during the baseline study. In the course of the field work, intensive observations were made on farming practices of five farmers in each village (University of Birmingham *et al.*, 1998c; 1999a; Nunan, 2000).

Systems

The locations and principal distinguishing characteristics of the 25 villages are presented in University of Birmingham *et al.* (1998a, p.24-25). A picture emerges of great heterogeneity, both of farming systems and local employment. One major reason for heterogeneity is soil types (ibid, p.38). To the north east of the twin cities the soils are black cotton (vertic), and to the south west they are red (alfisols). The dominant food cropping systems on vertic soils are *kharif* Season (the wet south-west monsoon, June to October) cotton (*Gossypium herbaceum*), onion (*Allium cepa*), potato (*Solanum tuberosum*), green gram (*Phaseolus aureus*) groundnut (*Arachis hypogaea*), followed by *rabi* season (drier north-east monsoon, November to February) sorghum (*Sorghum bicolor*), wheat (*Triticum aestivum*), safflower (*Carthamus tinctorius*) and chickpea (*Cicer arietinum*), mostly maturing on residual moisture stored in the soil. On the alfisols, the dominant *kharif* cropping system is rice based (*Oryza sativa*) (usually drilled, rainfed paddy) with increasing areas of mango (*Mangifera indica*) orchards, and some cotton and maize (*Zea mays*). In the *rabi* season, rain

and residual soil moisture permitting [rainfall data and trends over time are presented (University of Birmingham *et al.*, 1998a, Figures 4.1-4.8), green gram is commonly grown. Rainfall also varies across the peri-urban area. It falls into the Northern Transitional Zone of Karnataka State, with mean annual rainfall just exceeding 1000 mm to the west of Dharwad, and < 700 mm to the east. Furthermore, these generalisations of cropping systems hide great local variation. Thus, some villages specialise in floriculture (roses, gylardia, chrysanthemum), vegetables (often sewage irrigated), potato, mango and sapota (*Manilkara achras*). This heterogeneity is in stark contrast to peri-urban Kumasi, where there is less spatial variation in cropping systems.

In the "Improved Utilisation of Urban Waste Project" (R7099), the main cropping activities of the participating farmers, land area cultivated, cattle per farm and soil amendments are given (Nunan, 2000, p. 11). It was apparent that farmers have extensive knowledge about soil fertility maintenance, and prefer to use organic amendments wherever possible. Fallowing does not feature, and cropping intensity on farmed land is well over 100% (exact data not available, but two crops per year are the norm in the peri-urban zone).

One system which has been reasonable well characterised is the sewage irrigated system (Hunshal and Sindhe, 1997; Hunshal *et al.*, 1997). Apart from the sewage irrigated system, knowledge on production systems is still rather general.

What is known about changes to production systems around Hubli-Dharwad driven by urban development

The estimated current (2000) population of Hubli-Dharwad is 800,000, and the mean population density of the urban area in 1991 (time of the last census) was 3395 persons km^{-2}, when the population was 648,000. By Indian standards this is quite low (Indian 1991 mean urban population density was 5953 km^{-2}), part of the reason being that between the two cities, but within the municipal boundary, there are still areas of farmland. The mean population density of the surrounding rural areas in 1991 was 181 km^{-2}, which is moderately high for a rural area (for comparison, see population densities for other peri-urban zones in Chapter 2. In the 1991 census, 50.5% of the city-region's population was classed as urban.

Evidence for Dharwad District points to increasing intensification of land use, for it shows that areas cropped have generally increased particularly during

the 1980s (University of Birmingham *et al.,* 1998a, p.43). However, there is little sign that urban growth is a significant cause (ibid, p.44). Yet there has been a move towards cash yielding enterprises which is seen as taking advantage of proximity to Hubli-Dharwad (ibid, p.46). A particular case is that of the increase in mango farming, which uses local urban marketing institutions and copes with the increase in household non-farm employment (ibid, p.48). Floriculture is also rising and this is seen as due to the proximity of an urban market (ibid, p.50). There is increased growing of horticultural crops for urban markets and increased growing of crops which are processed in urban areas (e.g. mango and tomato) (ibid, p.64).

A feature of production systems around Hubli-Dharwad, particularly cash cropping systems, is that many primary producers are not dependent upon the twin cities for marketing (University of Birmingham *et al*., 1998a, p.50-51). For example, chilli is marketed mainly at Sirsi, 100 km west of Hubli, potato is marketed in Belgaum, 75km north of Dharwad, and although the mango pulp factory near Hubli accounts for purchase of a lot of local production, much mango is still transported to Bombay for export, and to many parts of India for the fresh market. Flowers are marketed in Hubli, but also in Belgaum, where higher prices can be obtained. Cotton is marketed in Gadag, as well as Dharwad. Thus, the effect of the urban area upon cropping systems is rather less than might be expected from the size of the cities. However, the cities are important for marketing food crops, as resource flow diagrams show (Nunan, 2000, pp. 47 - 50). A table in University of Birmingham *et al*. (1998a, p. 51) shows that a considerable proportion of food crops are marketed, ranging from 20 - 22% for sorghum (local name: *jowah*) to 70 - 80% for wheat and rice in Hubli-Dharwad. Fresh vegetables (tomato, cabbage, cauliflower) are marketed in Hubli-Dharwad, much of the vegetables being sold through wholesale intermediaries (University of Birmingham *et al*.,1998a, p.52).

There has been no spatial analysis of urban effects upon agricultural production or soil fertility around Hubli-Dharwad. Studies of production have usually been at the taluk (sub-district) level, as that is how agricultural statistics are collected (e.g. University of Birmingham *et al*.,1998a, p.39-40). The resolution of these statistics is too coarse to be able to identify any peri-urban effects.

The only trends that have been described are temporal. For example, farmers in four villages were asked to describe changes in cropping systems from

the 1950s to 1990s (University of Birmingham *et al*., 1998a, after p.44, graphs 4.6-4.9), and these showed considerable changes over time. However, a note of caution must be sounded when this form of evidence is collected. The same farmers were also asked to describe trends in rainfall, and for Mugad they claimed that rainfall had halved since the 1970s, whereas rainfall data show that annual rainfall had increased over that period (ibid, Fig 4.5). Other temporal data have been collected at even coarser resolutions, at the district level (ibid, p.42-44). The conclusion is that there is a significant gap in knowledge about effects of urban growth upon production systems.

One effect of the urban area upon production systems has been via competition for unskilled labour between near-urban farms and urban employment (factories, construction work). An example of this and the effects upon farming practice was cited in University of Birmingham *et al*. (1998c, p.10). Farmers in Navalur village on the edge of Dharwad have found that the location of a textiles factory adjacent to the village has resulted in a significant shortage of labour at wages they can afford to pay (Rs 50 d^{-1} compared to Rs 80 d^{-1} paid by the factory). Farmers are responding by tilling the soil earlier in the season to expose it to the heat of the sun, so reducing insect pests and (it is claimed) increase levels of nitrogen. Those that use urban solid waste (USW) from the municipal dump now spread the waste onto fields prior to taking out pieces of glass and stones, to cut down on labour requirements. Waste pickers are then admitted to the fields to sort out and take away plastic, which they then sell for recycling. The farmers then plough in the USW. Previously, USW would have been sorted prior to spreading on the fields. Another response by farmers to higher wage levels has been to develop mango orchards. On the other hand, in more distant areas which are more agrarian and prosperous due to irrigation, wages are higher but there have been significant reductions in the proportion of population engaged in farming, indicating mechanisation University of Birmingham *et al*. (1998c, iv).

Characteristics of principal stakeholders in crop production

Identification of stakeholders in the waste stream was conducted in University of Birmingham *et al*. (1999a, p.6-7). The characterization of farmers who have used urban solid waste is presented in some detail (ibid, p.30-32, 40-47), although these were a small sample. Characterization of small-scale farmers in the village of Mugad are presented (ibid, p.27-29, 33-39). These, too, were a limited sample, but give some indication of farmers and their livelihoods. Other

peri-urban stakeholders were characterised to some extent in the Baseline Study (Hunshal and Nidagundi, 1997).

Livelihood strategies of the poor who are involved in crop production

Farm maps and resource flow diagrams (originally drawn by the farmers) for two contrasting villages are presented (Nunan, 2000, pp. 47 - 50). The participating farmers were at the smaller end of the scale. The resource flow diagrams were descriptive only, and no data of the magnitude of flows were collected, so are deficient in that respect. Nonetheless, they indicate areas where future research workers should concentrate if they wish to characterise livelihoods.

What is known about potential strategy options for interventions in crop production

The only intervention strategy which was investigated around Hubli-Dharwad was the effect of composted urban solid waste (USW) with various amendments upon kharif season crops grown by farmers in four peri-urban villages. These experiments were described in Nunan (2000), and results are presented in Table 3.1. For further details of the composts used see Chapter 5.

The first season's results indicated that in two villages, the addition of modified USW had no effect upon yields of crops, but significant effects were observed upon groundnut and potato, with USW plus night soil having the greatest effect. Moreover, ranking of the effects of composts upon crops also indicated that adding night soil to USW was the most beneficial treatment. However, one year is considered to be too short a period for accurately determining the effects of organic soil amendments, and longer term studies are desirable. The experiments were limited in scope, and thus yielded knowledge for only a small sector of peri-urban activities.

What is known about dissemination of knowledge to the peri-urban poor

In Hubli-Dharwad, the means by which knowledge was disseminated to poor farmers during projects was via the participation process, and its effectiveness was not tested. The main extension agencies, the Karnataka State Departments of Agriculture, Horticulture and Livestock, operate the Training and Visit system, which as currently implemented appears to be confined to more

co-operative and 'progressive' farmers, and without a signal change in institutional attitudes and incentives for extension officers would be of little use in reaching the poorest sector. The main agency involved in generating potential interventions, the University of Agricultural Sciences, co-operates closely with the State extension agencies, and interventions developed so far are mostly

suitable for high input systems. However, individuals working in the University are aware of the need to target farmers without the means to apply high inputs. If appropriate interventions are developed, the most promising means of transfer of knowledge would probably be using some of the more effective NGOs operating in the area.

Table 3.1. Yields of crops in 1999 on-farm field trials, Hubli-Dharwad

Village	Navalur (5)	Mugad (5)	Maradagi (4)	Halyal (3)
Crop	Potato	Rice	Greengram	Groundnut
Treatment	t/ha (fresh)	t/ha (paddy)	kg/ha (seed)	t/ha (in shell)
Sorted USW	23.0 bc	4.04	485	1.41 a
USW + DS	20.6 a	3.60	407	1.38 a
USW + V	20.9 a	4.21	497	1.49 a
USW + NS	23.5 c	3.80	536	1.64 b
FP	22.6 b	4.30	427	1.45 a
s.e.d.	0.333	1.01	60.0	0.067
P (treatment effect)	<0.00	0.572	0.251	0.031
P (farmers)	<0.00	<0.00	<0.00	<0.00

Numbers in parenthesis after village names indicate numbers of farmers from whom valid results were obtained.

Navalur and Halyal data followed by similar letters indicate those means not significantly different (separated by Least Significant Difference).

USW = sorted and composted municipal solid waste

USW + DS = USW + distillery sludge

USW + V = vermicomposted USW

USW + NS = USW + night soil

FP = farmers' usual practice

s.e.d. = standard error of difference of means

P = level of probability in F test.

Source: Nunan (2000)

Cropping systems in Kumasi peri-urban interface

Characteristics of major cropping systems

During the inception phase of the Kumasi Natural Resource Management Project (R6799), 65 (or 66 or 67, reports differed) villages were surveyed during the Village Characterisation Survey (VCS). These were located up to 35 km and in all directions from the city centre. This survey enumerated the villages in which certain crop species were present, but did not characterise the proportion of cultivable land assigned to each (Blake *et al*., 1997a, p. 54) nor specify the cropping system in which each species was grown. Scientific binomials were not used, so in some cases where only the English vernacular was given, it was not possible to determine the species. For example, 'yam' is presumably one or more members of the genus *Dioscorea*, but no further information was advanced. It is probably *D. alata*, the greater yam, or *D. rotundata*, the white guinea yam. 'Cocoyam' and 'water cocoyam' were listed, and refer to *Xanthosama sagitifolium*, and *Colocasia esculenta,* respectively (Adam *et al*., 1998, p.136-137). Taro was also referred to (Blake *et al*., 1997b), and from the husbandry details it is inferred that it is the same as water cocoyam (*C. esculenta*). Beans were also referred to, without any further qualification. This is an area of detail to which projects need to pay more attention.

The principal staples of the area, maize (*Zea mays*), plantain (*Musa* spp.) and cassava (*Manihot esculenta*) were present in all the VCS villages surveyed (with the exception of cassava being absent from one). 'Yam' and cocoyam (*X. sagitifolium*) were present in 58 and 56 villages, respectively, whilst water cocoyam (*C. esculenta*) was present in 50. Many villages also grew vegetables, particularly Solanaceous species: tomato (*Lycopersicon esculentum*), 'pepper' (presumably chilli, *Capsicum frutescens*), aubergine or 'garden egg' (*Solanum melongena*), and non-Solanaceous okro (*Hibiscus sabdariffa*) all being found in > 58 villages out of 65. The other predominant crop species was oil palm (*Elaeis guineensis*), present in 52 villages, and cocoa (*Theobroma cacao*), in 48.

More detailed participatory surveys were conducted in six villages, where farming systems were described. These villages were samples located at various distances from Kumasi (10 to 40 km from the city centre) and in various directions. Findings from these surveys were described in some detail (Blake *et al.*, 1997b, p.23-111), but presented in an anecdotal manner, with little analysis.

Also, vernacular or non-specific English names were used for crops, and inputs and outputs recorded in local measures without conversion. This reduced the usefulness of the report.

The striking difference in farming systems between Kumasi and Hubli-Dharwad is the homogeneity of the former compared to the apparent heterogeneity of the latter (University of Agricultural Sciences *et al*., 1997; University of Birmingham *et al*., 1998a). Besides the differences engendered by two contrasting soil types around Hubli-Dharwad (vertic and alfisol), various villages often specialized in particular cropping systems, such as rice, potato, wheat-sorghum, cotton-chilli, floriculture, mango, etc. This degree of specialisation seemed to be absent from around Kumasi. The farming systems around Hubli-Dharwad were dominated much more by livestock, particularly buffalo for milking and oxen for draught power and transport (see Chapter 4). The dung from the beasts was a significant factor in maintaining soil fertility in the peri-urban area, but this option was not available to farmers around Kumasi.

The principal cropping system around Kumasi was traditional maize – cassava – plantain – cocoyam mixed cropping, and was present in all six villages, predominantly practised by women (Blake *et al*., 1997a). Men tended to be engaged in cash cropping, the commonest forms being either tree crops (oil palm or cocoa) or vegetables (tomato, egg plant, cowpea, along with a much wider range of species but not found in every village). In wetter areas such as valley bottoms, crops that could take advantage of moist conditions were grown (colocasia taro, rice). Free-range small livestock (poultry, sheep) were present in all villages, and intensive poultry units were present in four villages. Cattle were present in only one village. Most villages had banned goats due to their destructive feeding habits.

The main differences between villages were determined by proximity to Kumasi. Respondents in all villages confirmed that fallow periods had shortened, and that soil fertility had declined as a consequence, but this effect was more marked nearer the city. In the two villages furthest from the city (at 30 and 40 km distance), rice (*Oryza* spp., presumed to be *O. glaberrima*) was grown as a food and cash crop. However, it needed long fallow periods (six years was cited), otherwise weed burdens increased. Cocoa plantations were being rehabilitated and new ones were being established in these two villages in response to much improved cocoa prices. There was some evidence of agricultural intensification, in that chemical herbicides were used on intensive sole maize and on rice, and

intensive maize was sown in rows. Otherwise, cropping systems were similar to those found in villages closer to Kumasi, albeit with longer fallow periods due to lower pressure on land.

Another survey, not funded by NRSP, but conducted in eight peri-urban villages around Kumasi (Kasanga, 1998, p.98), showed that the great majority of female farmers (81%) grew food crops and on small farms of less than 0.8 ha, the equivalent figures for male farmers being 65% (see Table 6.12, Chapter 6). Unfortunately, the manner in which the data were presented did not permit a clear analysis of farming systems. It is possible to say that this survey confirmed other reports, that the major food crops were maize, cassava, plantain and xanthasoma taro, in that order, and that proportionally fewer male farmers grew food crops, and proportionally more grew vegetable crops than female farmers. 54% of male vegetable farmers were single, supporting other work showing that young males dominated this sector. Often these men had migrated from the north.

The great majority of farmers paid nothing for the land on which they farmed (81% of females and 74% of males), with a smaller proportion involved with share cropping (12% of females and 17% of males), but those who had access to land for no charge did not have security of tenure, either. 78% of female and 62% of male farmers still practiced bush fallowing (for further details on this subject, see Tables 6.13 and 6.14, Chapter 6). Farms run by male farmers were on average only slightly larger than for female farmers, but they tended to fallow for longer periods, indicating that crops occupied less of the farm at any one time. Data on livestock numbers from the same survey are presented in Chapter 4.

Thus, this survey corroborated the findings of the main research project (KNRMP), that food cropping with very short fallows dominated farming activities, with very few livestock in the system to help maintain soil fertility. This survey also supported those findings of the main research project that farmers overwhelmingly stated that tenure was not their main constraint, but that lack of credit / finance and poor soil fertility were.

In the Village Characterisation Survey (VCS), in 94% of the villages at least some farmers used chemical fertilizers, commonly 15:15:15 and ammonium sulphate, usually on vegetables. The proportion of villages where at least some farmers used insecticides, fungicides and herbicides were 88%, 66% and 58%, respectively. It was not stated which particular pesticides were used, nor upon what crops. At least some farmers used poultry manure in 26% of villages, but compost in only 3%. Poultry manure from intensive units was dumped and sometimes burned by roadsides, and its disposal was stated as being a problem for poultry farmers. In the VCS villages (numbering 65 to 67), there were 97 commercial poultry units. Depending on the source of information, 57% (Kindness, 1999) or 80% (NRI, 2000a, p.12) of available poultry manure was used by farmers. There was an absence of good data on production from peri-urban home gardens, and how important they are in terms of food / cash generation.

Field work was conducted in 1994 by the Crop Utilisation Dept. at the Natural Resources Institute, Chatham, Kent (NRI), with staff of the University of Science and Technology (UST) (Fereday, 1997). The author of that report reviewed and consolidated knowledge generated by that project's field work. Surveys were conducted in a range of villages (reportedly 14, but profiles for only five are presented) located from 16 to 25 km from Kumasi, all on main roads (Table 3.2).

Table 3.2 .Main horticultural and staple crops grown in Mim and Kodie villages in a survey conducted in 1994

Horticultural species	Range of plot sizes (ha)	Staple crop species	Range of plot sizes (ha)
Tomato	0.2 – 4.0	Cassava	0.4 – 1.2
Okra	0.1 – 1.2	Plantain	0.1 – 0.6
Aubergine	0.1 – 0.8	Maize	0.2 – 2.0
Cabbage	0.4 – 0.8	Xanthosoma taro	0.3 – 1.2
Chilli	0.4	Cowpea	0.4 – 0.8

Source: Fereday (1997)

Fertilizer (usually various types of NPK) was applied to horticultural crops, but not to staple crops. These had to rely upon the residual effects of fertilizers applied to horticultural crops, if planted in the next cycle. There seemed to be little knowledge of organic manures with only a few farmers who kept poultry using the manure on horticultural crops. Reasons given for not using organic manures included: lack of knowledge, no access to manure, not as effective as chemical fertilizers and too bulky to transport.

Comments on soil fertility were that it had declined over time due to shortening of the fallow period (indicating an increase in cropping intensity) and the lack of, or decline in the use of fertilizer.

- When asked about pest and disease problems, various categories of pests were identified by farmers (e.g. beetle, caterpillar, cricket, nematode, blight). No scientific names were given in reports. There were few traditional methods for controlling pests and diseases apart from destroying infected plants. The commonest insecticide in use was 'Karate', a synthetic pyrethroid (lambda cyhalothrin), and 'Cymbush' (compound name not given). Farmers had little knowledge about identification of diseases, and tended to spray 'Dithane' (mancozeb), and if that failed to work, uprooted the plant to help slow the spread of the disease.

Main constraints identified were (Fereday, 1997):

- Non-availability of production credit, including finance for labour.
- Pests and diseases.
- No storage facilities for harvested produce.
- Lack of producers' associations or other leadership
- Costs of inputs.

The overall picture from the respondents (selection methods not presented) was of a farming system in rapid transition from low external input forest fallow agriculture for staples, to a higher input cash cropping system conducted largely by young males. Farming systems were still developing, and at the time of survey there seemed to be little indigenous knowledge about fertility maintenance and pest and disease control, all problems which followed in the wake of intensified production systems.

Surveys of farmers' perception of pest and disease problems in vegetable production were conducted in four villages within a 5 to 10 km radius of Kumasi (Critchley, 1998). This document provided a useful checklist of pests found by the author. Other reports apparently exist with details of diseases found, but these could not be located. The author's conclusion was that if farmers' perceptions of pest and disease problems that he observed are representative of the surveys which had been conducted in other villages, then farmers' knowledge of biotic factors reducing yield was greatly deficient. One consequence of this would be that any pesticides used could be inappropriately targeted and thus wasted, or at worst present a risk to the operator, consumer and the environment.

Overall, the characterisation of crop production systems is probably adequate for development of strategy options. However, the usefulness of the characterisation of production systems was limited by the lack of quantitative data on areas devoted to each cropping system. The existence of images from two aerial digital photography missions and GIS allows one way of rectifying this important gap in knowledge.

What is known about changes to production systems around Kumasi driven by urban development

Near the city, farming land is being sold by chiefs for housing development. Thus, less land is available for agriculture.

In the Village Characterisation Survey of KNRMP (Blake *et al*., 1997a, p.56) most villages reported changes in farming systems since 1983, the main ones being increased use of herbicide (53%), decreased soil fertility (32%), reduced fallow period (30%), and increases in maize and in vegetable farming (23% of villages reporting these). Fallow periods declined from an average of 6.2 years in 1983 to 2.8 years in 1997. In the six villages where PRA were conducted, reported changes were a move from intercropping to sole cropping of food crops, decreases in areas devoted to tree crops (particularly cocoa), and increases in vegetable production. Just which of the foregoing were changes driven by urban development was not ascertained, as farming systems would be expected to change in any case over time due to uptake of new technologies and increased population pressure. For example, a decrease in area of cocoa could be due to lower prices over the past decade, or to a perceived decrease in rainfall, which would not be a peri-urban effect. However, maps did indicate that tree crops were less frequent nearer the city (Blake *et al*., 1997a, Map 10) whereas the reverse was true of villages were tomatoes were grown (ibid, Map 11). The uptake of herbicide use appeared to be occurring mostly outside the peri-urban zone (ibid, p.81).

In a survey in 1994, trends in farming systems over time were ascertained from a range of farmers in five villages, mostly male (Fereday, 1997). The main features were:

- 1960s. More cocoa, plantain and xanthosoma taro. Much more forest and soils fertile, forest fallowing. High yields without fertilizer, bigger farms. Prices lower, so farming was not a profitable business. Mostly older people farming.

- 1970s. More cassava, maize and okra introduced, with decline of plantain and taro. Decline in soil fertility. Vegetables introduced, but not commercially.

- 1980-90s. Upsurge in production for market, including maize and cassava. 20 – 80% of the latter sold, 33 – 80% retained for home consumption. Vegetables increased greatly in importance, nearly all sold, although overall cassava was cited as being the most important crop, with tomato usually being ranked second. Soil fertility at its lowest, smaller farm sizes. More permanent cropping with rotations. Increased use of fertilizers and other agrochemicals by vegetable growers. More young farmers.

Figure 3.1 Diagram representing some farming systems for which the occurrence in the peri-urban area appeared to be related to distance from the city centre.
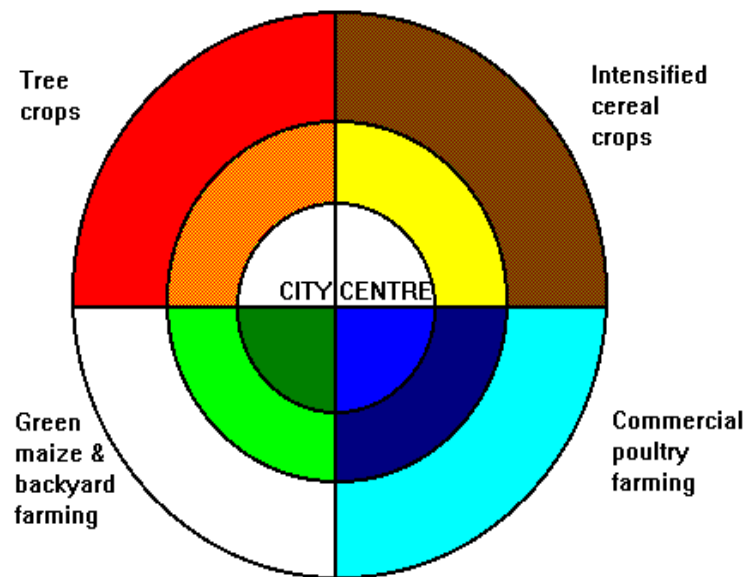
Darker shading indicates important or increasingly important, lighter or lack of shading

indicates unimportant or declining in importance. Circles at approx. 10, 20 and 30 km radius from city centre. *Source:* Blake *et al* (1997a, p.83).

Although this knowledge was concerned with changes over time, effects may have been accelerated by urban pressures, but as villages surveyed fell within a narrow range of distances from Kumasi (16 to 25 km, all on main roads), the surveys stood little chance of picking up spatial trends. For example, trends in soil fertility in relation to distance from Kumasi could not be described.

The research team in KNRMP concluded that although there were trends in agricultural practice with distance from the city, there was no trend in constraints and the team could not identify specific peri-urban effects in constraints (Blake *et al*.,1997a, p. 57).

The Village Characterisation Survey showed that reduction in fallow length was related to proximity to the city. Fertilizers were rarely used on food staples, fallows being the main means of restoring soil fertility. Farmers claimed that the bush fallow system will operate, albeit with a low level of output, with a fallow period as short as two years. However, rather than then changing to continuously cropped systems, farmers either give up farming or look for land elsewhere (on a sharecrop or rental basis), so they could continue the bush fallow system. There seemed to be a marked reluctance to invest in soil improvement for staple crops, in contrast to the Kano close-settled zone (Harris, 1998).

In a series of concentric circles at 10, 20 and 30 km from the city, the KNRMP team described some major farming activities for which the occurrence in the peri-urban area appeared to be related to distance from the city centre. Tree crops and intensified cereal cropping systems increased with distance from Kumasi. Conversely, green maize (for selling as fresh cobs) and backyard farming increased closer to the city. Intensive poultry were most numerous in the 10 - 20 km belt, then the 0 - 10 km zone, and were fewest when > 20 km from the city (Figure 3.1).

Within the city, there were continuously cropped systems, mostly in valley bottoms, where vegetables, sugar cane and colocasia taro were grown, with some semi-perennials such as plantain and increasingly with perennials such as oil palm. These farmers, although farming on Kumasi Metropolitan Assembly land, believed that the land was undesirable for building development (too poorly drained or swampy), and that effectively they have security of tenure. This is the form of intensification that would be expected when population pressures

increase (Boserup, 1965; Tiffen *et al*, 1994; Harris, 1998). The majority of these farmers were from other areas of Ghana.

In the 10 - 20 km zone, competition for land appeared to be most intense, and change in use of land most rapid. Apart from the commercial poultry units previously mentioned, intensive vegetable production was increasing. This was typically on small plots (< 0.5 ha), often farmed by in-migrants. There appeared to be a more entrepreneurial sector of the population consisting of young, male farmers who were engaging in vegetable growing and intensive poultry enterprises, often on rented land. The predominating traditional mixed cropping bush-fallow system was breaking down as fallow periods shortened.

On the peri-urban fringes (> 20 km), family farm holdings still predominated, few of which were > 2 or 3 ha, except for tree crop plantations. Cocoa was declining in importance whilst oil palm was increasing. Food cropping was conducted on a traditional bush fallow system, the average fallow period being four to six years. There was evidence of some intensification of cereals, with increased inputs of herbicides (atrazine on maize, bentazone on upland rice) and fertilizers. The team had not determined the origin and status of these progressive cereal farmers. However, the presence of food crop intensification indicated that lack of finance or knowledge was probably not the major constraint to intensification of food crops in the peri-urban interface. These particular stakeholders need to be more accurately characterised.

To highlight the unusual nature of the land use patterns around Kumasi, and the influence of urbanisation upon production systems, it is pertinent to contrast them with those described in a study funded by DFID (Scoones and Toulmin, 1999), in which the consequences of various farming systems on soil fertility were described. They reviewed, amongst many others, three studies of high rural population density with market-oriented farming systems. These were Tumbau in the Kano Close Settled Zone, northern NIgeria, Kisii near Kisumu, western Kenya, and Machakos, southern Kenya. It was concluded that broadly soil fertility in these agricultural systems was being maintained.

Factors common to the three sites were:

1. High population densities (800 km^{-2} at Kisii, 36 to 383 km^{-2} at Machakos and 223 km^{-2} at Tumbau), leading to high labour availability either from families or for hire.
2. High livestock population densities, with good integration between livestock and crops (animals often used for draught or haulage, crop residues and fodder fed to livestock, and manure diligently collected and applied to fields). For this, some degree of stall feeding was necessary.
3. There was a low to moderate dependency upon external inputs: inorganic fertilizers being used at moderate levels (57 kg/ha at Kisii, < 50 kg/ha at Tumbau, no data for Machakos).
4. Trees were important components of the systems, for fodder, fuel wood, fruit and cash crops.
5. Grain legumes were an integral part of the system. At Tumbau, the contribution of nitrogen fixation from groundnut and cowpea varied from 0 to 37 kg N/ha, depending on cropping pattern (Harris, 1998).
6. High cropping intensity, with limited fallow or none at all.
7. Secure usufruct rights or title to land.
8. Good marketing opportunities for excess produce and cash crops.

There were also differences between the locations:
9. Annual rainfall differed greatly (1350 to 2050 mm at Kisii, 600 to 1200 mm at Machakos, 570 mm at Tumbau).
10. Soil at Kisii were deep, well drained volcanic of recent origin, fertile but with a tendency to fix phosphorus. At Machakos and Tumau, soils were alfisols of moderate fertility.
11. Main crops grown at Kisii were maize and beans, with smaller areas of sweet potato, finger millet and vegetables. Main cash crops were tea, pyrethrum, bananas, coffee and sugar cane. At Machakos the principal food crops were maize, beans, cowpea (*Vigna unguiculata*) and pigeon pea (*Cajanus cajan*), with vegetables (tomato, cabbage, kale (*Brassica oleracea*)) where conditions were suitable, and cotton and coffee (*Coffea arabica*) as cash crops. At Tumbau, the farming system was based on cereal and leguminous grain crops: millet (*Pennisetum typhoides*), sorghum (*Sorghum bicolor*), groundnut and cowpea, usually intercropped in a single season. Trees were retained in fields for fruit, edible leaves, silk cotton and firewood.

It is worth comparing the above examples with peri-urban Hubli-Dharwad and Kumasi. There was little evidence of a decline in productivity around Hubli-Dharwad (as opposed to a general stagnation or decline across Karnataka State, both rural and peri-urban (Satish Chandran, 1993)), and it is notable that many of the above contributory factors also pertained in the Hubli-Dharwad peri-urban interface, particularly 2, 3, 5, 6, 7, and 8 in the list above. The Hubli-Dharwad

PUI population density was 181 km^{-2} in 1991, fairly high for a rural area, and labour intensive cropping systems were used (although farmers claimed that labour was not abundant, at least not at prices farmers were willing to pay). The Hubli-Dharwad PUI had a high cropping intensity (no fallows), high livestock numbers, a crop rotation based largely upon cereal and legume grains, but with few trees integrated into the farming system (maybe because cotton stalks were used as cooking fuel by the poor). At Tumbau, near Kano, farmers applied a mean of 4.3 t/ha of livestock manure annually to the holdings, although rates per field within a season varied from 0 to 17.5 t/ha (Harris, 1998). This was remarkably similar to the mean quantity applied on farms around Hubli-Dharwad (4.6 t/ha a year, Universities of Birmingham *et al*.,1999a).

It is believed that the Kumasi PUI also has a high population density (although there are no reliable recent figures), farms have a low dependency upon external inputs, and produce marketing opportunities appear to be good (but see below), but there the similarities end. The critical constraint to productivity is that secure usufruct rights have been eroded by illicit disposal of land for building plots, mostly without compensation. This situation was described by Boserup (1965, p. 91), 'When tribal chiefs manage to be confirmed as private owners of tribal land [*as has effectively occurred in Kumasi*: author's note] a breakdown of the whole tribal organization of investment may ensue…'. The reluctance of farmers to invest in building up soil fertility and applying other agricultural inputs is likely to be a direct consequence of their lack of security of access to cultivable land (Blake *et al.*, 1997a). This analysis appears to be somewhat at variance with the findings reported above (Kasanga, 1998, p.98), that farmers overwhelmingly stated that tenure was not their main constraint, but that lack of credit / finance and poor soil fertility were. The issue of land tenure is explored further in Chapter 6.

Markets were not well characterised, although ten 'market queens' (controllers) were interviewed (Adam, 1999a, p.9-10). It was found that non-perishable foodstuffs could come from great distances, from where lower units costs may prevail, or have other comparative advantages such as availability of larger tracts of land, better climate or soils, lower biotic stresses, cheaper labour. For example, the interviews showed that some maize was brought in to Kumasi market from Techiman, Brong Ahafo Region, yams from Ejura Kintampo, cassava from Greater Accra, millet and legumes from Northern, Upper East and Upper West Regions. However, quantities were not ascertained. Bulkier crops more suited to the local area such as plantain and cocoyams (xanthosoma taro)

were supplied from within the peri-urban region. Evidence presented was anecdotal, and incentives and disincentives to crop production due to marketing require further investigation.

There was also a much lower density of livestock (Chapter 4), particularly bovines due to tse-tse fly and absence of a tradition of keeping donkeys. Thus the availability of manure was low and practically all tillage and carriage of inputs were manual, all dramatically reducing productivity. The importance of draught for ploughs in short fallow systems was mentioned by Boserup (1965, p. 25). The absence of wheelbarrows and bicycles was also noticeable (R.M. Brook, personal observation); understandably, one of the constraints farmers cited for not using poultry manure was that it was arduous to transport. There was no integration between what livestock do exist and the cropping system, in that there was little attempt to incorporate manure into fields and neither were livestock systematically fed upon crop residues. One reason for the latter was that the diet of Kumasi was largely based upon tubers and plantains, which produce little by way of edible haulm, and sometimes these are toxic. Tubers and plantains are difficult to integrate with grain legumes, in contrast to cereals, so few legumes seem to be grown; if so, this reduces the opportunity to incorporate N-fixing crops into the system. Tubers and plantains also take up large quantities of K from the soil, which if not replenished eventually leads to deficiencies.

These factors all combined to lead to a production system starved of inputs, even the normal bush fallows. Evidence of this was the low yield of maize (Table 3.3), which is poor for a region with weakly bimodal 1,488 mm rainfall p.a. (CEDAR, 1999, p.11). Nutrients are being mined from the soil, one consequence of which was that crops have low resistance to pests and diseases. It is interesting to note that 20 km or more from Kumasi, farmers are intensifying production, particularly maize and rice. The application of herbicides is quite an unusual feature in small holder agriculture in Africa, and suggests that where farmers feel more secure about their continued access to land, they are prepared to invest in the productivity of their land. The renewed establishment of cocoa farms is further evidence of this. The hypothesis that there is a link between perception of secure access to land (even when no formal title is held) and willingness to invest in longer term farming enterprises needs to be tested.

Table 3.3. Grain yields from poultry manure on maize demonstration plots around Kumasi.

	Yield in major wet season	Yield in minor wet season
Unmanured	1714 kg/ha	1333 kg/ha
Manured	2571 kg/ha	1809 kg/ha

Source: Adam *et al.* (1999)

Further light can be shed upon the unusual constraints on production in peri-urban Kumasi by considering agriculture in urban areas. Strictly speaking this should be outside the remit of an investigation of the peri-urban system unless it impinges in some way upon peri-urban productivity or livelihoods. Although in Kumasi such effects were indirect at most, the KNRMP did consider agriculture in urban areas, and the contrasts are worth examining. Researchers found that there were two forms of urban cropping activity in Kumasi: backyard farming and agriculture 'in the gaps' (crop production on vacant, low lying land between urban developed zones).

Backyard crop production was examined in three contrasting residential areas of the city (Adam, 1999b, p.99-125), 30 plots in each being selected for study. The average age for backyard farmers was quite high, 42% being 50 years or older, and had been resident in the city on average for more than 24 years. 69% of respondents were Ashantis. Most had jobs within the city. 90% of backyards had plantain and 44% grew cassava. Additionally, 36% of houses grew an assortment of vegetables and fruit such as tomato, okro, chilli, aubergine and cabbage. 34% cultivated xanthosoma taro and only 11% grew maize. It is interesting to note that tree crops were important components of backyard cropping systems, 44% having oil palm, 39% having mango, 36% having pawpaw (*Carica papaya*), 28% having avocado (*Persea americana*), 22% with orange (*Citrus sinensis*), 19% with apple (*Malus pumila*), 17% with guava (*Psidium guajava*) and 9% had cocoa. Note the existence of multiple responses. 23% of houses also kept some poultry and 8% had sheep or goats.

Only 4% of respondents depended upon urban agriculture as their sole means of livelihood, 75% of those respondents coming from a high density, low class residential area. The greatest number of respondents (91%) engaged in urban agriculture to supplement their incomes from other urban activities. 62% also cited the activity as a hobby. Houses that used public land for their activities constituted 12% of those surveyed, and 88% conducted their cultivation on

private land. 69% of the properties were leasehold, 13% were occupied by squatters, 7% were rented and 11% of respondents were caretakers of the property. Thus, it could be concluded that the great majority felt reasonably secure in their tenure, only 9% stating that insecurity of tenure was a constraint.

When asked about crop protection and other cultural practices, 84% said that they weeded their plots, 57% fenced them, 11% sprayed with agrochemicals, 33% watered their crops, but only 7% applied any fertilizer or manure (whereas approximately one quarter of houses had livestock of some form). When asked about crop residues, 31% said that they burned or disposed of them, 48% burned part of them and applied the rest to the crop, and only 13% responded that they used them for soil enrichment. None of the respondents used crop residues to feed livestock.

78% of households use their own labour to cultivate their plots, whilst 22% employed some hired labour. None grew crops solely for sale, but 20% sold at least part of their produce. 33% grew crops only for home consumption, and the remainder grew them for multiple reasons, including for giving as gifts. For those crops which were sold, the median annual income generated from sale of produce was ¢100,000 (£16)[1], which was very similar to the median financial input. For 86%, the annual value of outputs was < ¢200,000 (£33), and the mean contribution to the household food budget was < 5%. However, for every cedi invested, the owner estimated to get 4 cedi in return.

92% of urban farmers entered the activity upon their own initiative, but 80% said that they would appreciate some training, although only 24% had received any form of advice from extension agents. When asked about problems associated with backyard farming, 42% replied that biotic constraints were the most serious, whilst 12% cited poor or infertile soils. 53% would have liked more space. There seemed to be no discernible trends either into or away from particular kinds of cropping, numbers entering and leaving being roughly in balance.

The above kind of urban agriculture was rather different in nature from farming in the urban gaps. This was an extensive study (Agbenyega, 2000; Adam, 2000a) covering 59 respondents in three areas located between housing or industrial zones. Aerial digital photography was used to outline the plots on the Kumasi Geographical Information System (KUMINFO). The areas were generally low lying, often along water courses and rather swampy. Unlike the backyard farmers, the majority (81%) were non-Ashanti in origin, tended to be

male (83%), and 66% were under 50 years of age. Educational level tended to be low (32% illiterate, 12% up to primary standard) and occupations were at the lower end of the income scale (27% labourers, 7% watchmen, 14% artisans, 22% farmers). 61% lived within 1 km of their cultivated plot. 25% were full-time cultivators.

Most of the land was owned by Government agencies, but nevertheless, 92% felt secure in their *de facto* tenure (*sensu lato*). Many had been farming these plots for 20 years or more and had experienced little or no interference from the true owners. 73% were growing trees on their land, often as boundary markers, which is one common sign of a feeling of security. 81% grew plantain or banana, 54% grew maize, 40% colocasia taro, 34% each of cassava, xanthosoma taro and sugar cane, 20% aubergines, 29% oil palm, 10% mango, and 22% grew other species of trees. 48% also kept poultry, 14% had fisheries, 9% had small ruminants, and another 9% had both poultry and small ruminants.

The predominant reason for cultivating in the urban gaps was to supplement household food supplies (41% giving this as the sole reason), 7% gave income and employment as a reason, and 49% said both food security and income were the reasons. 34% of respondents' families ate all the produce from their land. Thus, this form of agriculture seemed to play a more significant role in livelihoods than backyard farming.

When asked about inputs, 61% applied none at all, 7% applied manure, 14% applied fertilizers and manure, and 18% applied fertilizers and other agrochemicals. 83% left crop residues on their plots, and 12% burned them. Only 10% cited poor soil fertility as a constraint, the biggest cited problems being theft of produce (33%) and insufficient food (31%). In contrast to backyard and peri-urban farms, biotic constraints figured quite low in the ranking of constraints, only 12 % of cultivators citing these. On the other hand, 46% said that they required greater financial resources to increase production. In terms of intensity of production, these plots were no greater than peri-urban valley bottom farming around Kumasi, although in the latter cases the plots consisted mostly of annual cash crops (vegetables, with little or no perennial component). The contrasts of these two forms of urban crop production with peri-urban agriculture are revealing. In urban agriculture, the cultivators clearly believed that they had security of access to land. Interestingly, this did not manifest itself in investing in the fertility of soil (a common manifestation elsewhere), but in planting of economic tree species (another common sign of 'ownership'). In the instance of

valley bottom cultivation in the urban gaps, in any case soil fertility would likely be replenished through contamination of watercourses with sewage and periodic inundation during floods. In contrast, the decline in the perennial component in peri-urban agriculture is a common symptom of insecurity. The other symptoms were short term management approaches (mining of soil nutrients, growing of short duration crops and 'hit and run' horticulture enterprises).

The issue of soil fertility maintenance is worthy of further examination. It is interesting to see, even when access to land was secure (in both urban areas and on farms > 20 km from Kumasi), little attention was paid to maintaining fertility. On more distant farms, soil fertility was restored using the time honoured technique of bush fallowing. However, there seems to be a shortage of indigenous knowledge about soil fertility management apart from fallowing, which may have stemmed from the fairly recent decline in the effectiveness of this technique due to increasing pressure on land. Also, the lack of integration of livestock and crop production is worthy of note, in contrast to the three case studies from elsewhere in Africa described above (Scoones and Toulmin,1999) and around Hubli-Dharwad. This may be attributed to lack of experience of maintaining soil fertility using manures, and cultural issues surrounding the utilisation of waste materials. But whatever the reasons, the problem of low fertility in the peri-urban interface is likely to intensify as a constraint, but it is hard to see how this may be remedied when farmers feel that their usufructuary rights are insecure.

However, the hypothesis that in Kumasi, insecurity of land tenure discourages investment, may not get to the root of the matter. Whereas the blame is placed upon the nature of the traditional land management system, it may be that the operative factor is the speed and unpredictability with which changes in the possession of rights are implemented, thus determining the real or perceived risks involved in investments. The cases around Kumasi where young men, mostly non-indegenes, who intensively farm vegetables for sale in Kumasi on a "hit and run" basis, implies that they judge what remaining capacity can be extracted from the soil or what minimal inputs will keep it productive for profitable use in the short term.

A focus on speed and unpredictability raises questions of the importance of the rate of urbanisation as a factor in the maintenance for agriculture, tree growing and animal husbandry of land affected by the peri-urban interface. This may be a more basic determining factor than tenure, but one which produces substantially different opportunities for livelihood strategies of the poor as it

works its way through varying systems of land tenure management. Research built on that already undertaken in Kumasi, Kano, Machakos and Kisii could possibly explain the differences observed in ways which would permit the formulation of land management strategy options which maintain and increase opportunities for the rural poor to fashion improved livelihood strategies when affected by urbanisation.

Characteristics of principal stakeholders in crop production

Principal stakeholders in crop production were identified in (Blake *et al*.,1997a,; Kasanga, 1998). Food crop farmers were often women with family responsibilities, crops being sold to provide for their families. Some women engaged in trading, and sometimes finance from trade was used to pay for labour on the farms, but not, it appeared, for inputs to intensify agricultural production.

Male indigenes tended to be involved with tree crop farming, and some in vegetable farming. Other vegetable farmers were often young men working on rented land, often without family responsibilities. They may also engage in labouring jobs to make money, some of which is used for agrochemical inputs. In the short term, net flows of resources into vegetable farming may be positive, but one gap in knowledge is how long young men intend to stay in horticulture. The research team discerned an attitude in some men that they were using their enterprises to make money before moving to other occupations.

What is known about potential strategy options for interventions in crop production

Following the Inception Phase of KNRMP, soil fertility was identified as the main abiotic constraint to crop production. Farmers were known to be aware of the problem, but remedial action was constrained by financial and tenurial issues It was considered that there was potential to use waste products from poultry farms to address the decline soil fertility. The rationale for conducting this study (Blake *et al.,*1997a, pp. 102-107) included. If poor farmers cannot afford fertilizer inputs, then manure or compost is their only means for improving soil fertility, once the fallowing system has broken down.

- The quantity of manure available locally would probably be insufficient to fertilise all the mixed food crop systems.
- Farmers of the more intensive vegetable cropping systems were considered to be better candidates for adoption of any recommendations that might ensue.

- It was recognised, however, that secure land use rights was a crucial factor in determining whether recommendation would be adopted. These land use rights become less secure with proximity to the city.

Having opted for examination of the soil fertility issue, on-station trials were conducted at the horticulture experimental site at the University of Science and Technology, Kumasi (Adam *et al*., 1999). On farm trials were conducted in three peri-urban villages, Duase, Apatrapa and Darko. A PRA exercise was conducted with 31 vegetable growing farmers (including 14 female farmers), who were asked to select those amongst their number who would participate in the trials. The farmers consistently reported that their main constraints were cost of agrochemical inputs and labour, and access to cash to finance them. Surveys have shown that soil ameliorants used by farmers in peri-urban Kumasi consist of about 57% poultry manure and 10% mineral fertilisers. Vegetable growing was considered to be laborious, as it involved land clearance, digging, mounding or ridging and weeding. Some cited increasing numbers of pests, particularly termites and grasshoppers. Most farmers, although aware of the potential of manure to enhance crop production, nevertheless did not use it. Even where poultry manure was available, some farmers considered that it was too heavy or bulky to transport.

Compared to Hubli-Dharwad, the lack of low technology transport (ox cart or even bicycle), and animal draught power imposes significant constraints to improving productivity of the farming system. In some locations, shortage of land was cited as a constraint, and an incentive for growing short duration vegetable crops. Other reasons cited for growing vegetable were quick financial returns and their importance in the household diet. Tomato cropping was usually conducted in the dry season, and therefore plots were usually close to permanent water courses.

Results presented in Table 3.4. were obtained from major rains experiments (Adam *et al*., 1999) and a report delivered by Quansah *et al*. (2000) to the final workshop of project KNRMP. However, there were several problems with the reports. The explanatory text in the workshop report did not match results presented in tables, so which was the true account could not be determined. For example, on-farm trials were reported as showing no significant treatment effects, but tabulated data were accompanied by superscripts that indicate otherwise. The researchers stated that due to a range of factors, for the major rains experiments (on station and on farm), yields were considerably below what

could be expected from a well managed farm crop (normally 70 to 110 kg /100 m²). Therefore, the same must have applied for the minor rains experiment. Yields in the minor rains on-station trials were reported to be higher than for the on-station, major rains trial.

Table 3.4. Results of tomato fertilization trials around Kumasi.

	Tomato (on station) Major rainy season cv. Petomech VF II		Tomato (on farm). Major rainy season	Tomato (on station) Minor wet season cv. Power.	
Treatment	Fruit fresh weight (kg/100 m²)	% loss (disease, pests, cracked)	Fruit fresh weight (kg/100 m²)	Fruit fresh weight (kg/100 m²)	% loss (disease, pests, cracked)
No external input (control)	38.4[bc]	27.7	0.95[b]	7.15	22
Poultry manure @ 8 t/ha	50.6[a]	18.4	4.16[a]	20.5	9.4
[1] 60 kg/ha each of N, P₂O₅, K₂O (as 15:15:15 basal) + 50 kg/ha N & 57 kg/ha S (ammonium sulphate top dressing)	45.6[ab]	23	3.56[a]	8.33	36.8
Poultry manure + fertilizer at half above rates.	29.6[c]	28.8	4.57[a]	16.0	19.6

Means within one column followed by the same superscript letter are not significantly different.

Columns without superscript letters indicate lack of significant treatment effects.

[1] Fertilizer samples were analysed at UST, and showed actual nutrient content differed greatly from those stated for the fertilizer. Unfortunately, in the report there were contradictions in the analysis, so all that can be concluded is that the experimenters could not be certain what quantities were being applied

Source: Adam *et al.* (1999, p.2).

From the results reported (Table 3.3), it is difficult to understand how this conclusion was reached, notwithstanding the fact that different cultivars were used for the two experiments. In all three trials, application of poultry manure resulted in fruit yields that did not differ significantly from the fertilizer treatment, but with lower losses. Losses did not appear to have been analysed statistically. Economic analyses of application of poultry manure and fertilizers were carried out for the on farm trials, but it was acknowledged that due to very low yields, the results meant little. Essentially, the experiments were failures; this reduced the usefulness of the research as a basis for generating new strategy options to the point where the experiments need to be repeated to obtain usable results.

One experiment with okro was conducted on-station, where again application of poultry manure produced yields as great as the fertilizer treatment, but not significantly different from the no-fertilizer control. This was an indication of high residual fertility of research station soils, as a consequence of which it is not possible to extend results to on farm conditions. Nutrient balance (calculated from fertilizer input, nutrient off-take in crops and nutrients remaining in soils after the season) studies were conducted, but as no methodology was advanced, it was not possible to comment upon the utility of the resul

Brief details on mucuna cover crop experiments were provided by Quansah (2000) on experiments in both seasons, and more extensively in NRI (2000b), for the first season. The PRA conducted by the soil fertility team had revealed that a number of farmers were familiar with green manuring and cover crops. Some reported using cowpea as a cover crop between rows of maize. Other NRSP funded work in Ghana (Forest Agriculture Interface System project in Brong-Ahafo on fallow management) has indicated that mucuna (*Mucuna pruriens* var *utilis*) cover crop can be used to increase the yield of maize on poor soils. In 1998-99, in the KNRM Project, experiments with dry season tomato were run on farms in three villages, examining the effects of mucuna and grass mulches, burned and not burned. In 1999-2000, the effects of fallow, mulch, soil cultivation and mucuna green manure on the yield of dry season tomato were studied.   It   was   found   that:

- Mucuna cover crop reduced afternoon soil temperatures and maintained higher soil moisture content, when compared with traditional slash and burn.
- Tomato yields were generally better on the mulched plots.
- Mucuna mulch provided cover for crickets, which caused significant plant losses.
- Farmers appreciated the positive effect of mulching on crop growth in the dry season.

NRI (2000b) presented interesting data on the soil ameliorant effects of mucuna mulch for the first season's research (1998-99), such as effect on soil temperature, soil moisture content, but once again the rigour of reporting reduced the value of the output, as no depths of recording point were mentioned (thus rendering comparisons with other work impossible). Soil nutrient content was measured, but results were rather variable. However, similarly to the poultry manure trials, tomato yields were an order of magnitude lower than farmers would normally expect from the crops. One reason was very poor crop establishment, partly due to cricket attack

In 1999-2000, experiments upon maize grown with mucuna green manure were conducted, and although the maize appeared to be showing greater vigour with the mucuna, once again crop establishment was very poor. It should be mentioned that in some parts of west Africa, live mulching with mucuna in both maize and upland rice has been spontaneously adopted and adapted by farmers with severely degraded soil, so the technology itself has significant potential.

The effect of municipal compost was also examined, at application rates of 10 kg/m² (equivalent to 100 t/ha) on the growth a yield of tomato and cabbage at two peri-urban farms sites was studied over two cropping seasons (CABI Bioscience, 1998). On-station experiments using composts at rates of 2, 5 and 10 kg/m² and an inorganic fertilizer treatment (50 kg/ha 15:15:15) were also conducted. These composts were obtained from Accra, and were made from human night soil and domestic refuse at the Accra Metropolitann Assembly composting plant. The hypothesis was that composts derived from municipal compost would help control pests and pathogens, with supporting evidence from other work (ibid, p. 3-4) suggesting that compounds released during decomposition controlled plant pathogens.

.   However, in the event levels of pathogens were not high at the sites selected, so no effects were found, and the composts did not affect what few

diseases did occur. The exception was tomato wilt (*Pseudomonas solanacearum*) in one season, but there was no beneficial effect of composts against this; in fact, wilt was worse on compost treated than on untreated plots. There were significant effects upon growth and yield of tomato in the first season, possibly due to the very high rate of compost application. In the second cropping season, yields were low in all treatments due to 'poor weather conditions and poor establishment' (CABI Bioscience, 1998, p.2). However, in the first season, on-farm tomato yield from composted plots was equivalent to 0.6 -1.75 t/ha (Adam *et al.,* 1999, p.15), considerably lower than the yields of 7 to 11 t/ha that farmers considered to be the lower limits of profitability (ibid). The yields from nearby farmers' plots were not reported.

In the on-station experiment, in the first season it was found that for many of the parameters assessed, an application rate of 2 kg/m² was as effective as the higher rates of compost, and produced higher yields than inorganic fertilizer treatments and untreated plots. However, the differential between untreated and treated plots on-station were much smaller than in farmers' fields, indicating a high base level of fertility on the University research station (a not unusual phenomenon on developing country agricultural research stations, arising from regular applications of inorganic fertilizers). The second season experiments were afflicted with the same problems as the on-farm trials, and yields were so low that no useful information could be obtained.

Tests for coliform bacteria in compost were negative, indicating the temperatures reached during decomposition (80°C) killed all non-thermophilic bacteria, as well as fungal pathogens, nematodes, insects, their eggs and larvae. However, coliform bacteria were detected in soil later in the season, presumably from use of contaminated irrigation water.

It was concluded that application of municipally derived compost was effective in raising tomato and cabbage yields, but the economic aspects were not assessed. However, given the high rates used and the difficulties cited by farmers in transporting poultry manure, it is unlikely that farmers would adopt this compost as a soil amendment. However, the authors did point out that in Accra, the product was used by gardeners for landscaping and horticulture, and to a lesser extent by fruit growers. However, no further information on the wealth status or livelihood strategies of users was provided, so it was not possible to determine the likelihood of a similar Kumasi-derived product finding a market locally.

Composts were analysed for nutrient composition, and although there was a narrative, no tables of data were provided so a comparison with composts produced in Hubli-Dharwad was not possible.

From the evidence seen in CABI Bioscience (1998), Adam *et al*. (1999) and NRI (2000b) the knowledge of strategy options for land use and NR-based production systems interventions is inadequate. This was due in the main to the failure of field experiments in farmers' fields, and to high soil fertility levels at the UST experimental station which masked intended soil amendment effects. The exact reasons for failures of experiments were not identified in the reports (apart from generalities such as 'poor weather', 'disease problems', or 'poor establishment'). No information was provided on whether farmers' crops suffered the same problems, nor about yields that farmers were obtaining in adjacent plots, nor about who managed the experimental plots. Thus, it is not possible for future projects to learn from mistakes made.

What is known about dissemination of knowledge to the peri-urban poor

PRA exercises showed that the most readily available organic soil amendment available in the PUI was poultry manure, with between 57% and 80% of poultry manure around Kumasi already being used (Blake *et al.,* 1997a;). Kindness, 1999; NRI, 2000a, p.12).). PRAs conducted by GOAN (Ghana Organic Agriculture Network) indicate that farmers are aware of the yield advantages of poultry manure (claimed to be 30 to 50%). Field experiments (reported above) claimed that poultry manure could produce good vegetable yields at a cheaper cost than with inorganic fertilizers (although the evidence presented in Adam *et al*. (1999) failed to demonstrate this). Following this work, an extension guideline summary was produced and the Ministry of Food and Agriculture (MOFA) were approached to consider the possibilities of conducting an extension campaign based on the findings of the research (NRI, 2000a), despite the fact that experiments failed to demonstrate the anticipated benefits.

A one day training session was conducted with 49 extension officers, demonstrating recommended practical techniques for application. Following the training session, a project fact sheet was produced and distributed to 350 extension officers and the general public. Following this, extension officers in KMA and its contiguous districts held a total of 106 meetings, at which a total of 1582 people attended.

At these meetings, farmers were recruited to actively participate in the trial demonstration programme (which were biased towards the KMA district itself). Following the public meetings, the Regional Crops Specialist was invited by a local radio station to present the subject matter, at the end of which ten telephone calls had been received requesting further information.

Nineteen extension officers were actively involved in the follow up campaign, running training sessions in all the targeted villages. One of the villages was Assuyeboa, where farmers grow maize seed on contract, and who were already aware of the value of poultry manure. The intention had been to assess the farmers' knowledge, attitudes, skills and aspirations with regard to poultry manure before and after the campaign. However, the author reported (NRI, 2000b) that there were no records to show whether or not this happened. The regional crops specialist estimated, from follow up visits, that of those farmers who had applied poultry manure, only 40% had applied it correctly. NRI (2000b) exhibited some scepticism that farmers' knowledge had been enhanced as much as the extension officers claimed. Farmers were asked to evaluate poultry manure from a number of perspectives. The number of participants was impressive: n = 435; male = 342, female = 93, although the gender balance was a point of concern. However, it was not clear from the document whether all participants were also respondents. Therefore, here responses are ranked only, with a narrative indication of the value of the ranking exercise (with the exception of perceived effects of poultry manure, where the respondent figure (349) was given).

Perceived effects of poultry manure:

1. Improves crop vigour (92.0%)
2. Aids drought resistance (35.5%)
3. Results in big fruits or cobs (35.2%)
4. Increases yield (22.9%)
5. Cheaper than inorganic fertilizer (20.9%)

It was not clear why crop vigour was referred to separately from fruit size or yield effects; perhaps some respondents believed that the general term 'vigour' encompassed the idea of yield response. Clearly there were multiple responses, so for some respondents, yield or fruit size could have been a qualifier to vigour. The drought resistance effect was presumably linked to the higher organic matter levels that would follow application of poultry manure (which was mixed with sawdust bedding).

Disadvantages of poultry manure:

1. Difficult to transport/collect
2. Difficult to apply when wet
3. Bad smell
4. Bulky
5. Labour intensive

Nearly three times as many respondents cited difficulties of transport as any other constraints, so clearly this was a major factor. The lack of any transport intermediate between head loading and motorized vehicles (even wheelbarrows, bicycles or donkey carts) is the reason for this. As a consequence, any financial advantage of using poultry manure will have to take transport costs into account. In fact, the extension guidelines issued for the exercise (NRI, 2000b, p.12) tried to make a convincing case that even with transport costs, using poultry manure was more cost effective than using inorganic fertilizers. Clearly farmers did not agree with the economic analysis.

Perceived constraints to use of poultry manure:

1. Poor people need free or assisted transport
2. Transport costs high
3. Storage needed
4. Lack of access roads
5. Credit for poultry manure (for transport?)

Responses citing transport outnumbered other responses by nearly three times, and the other two constraints identified were linked to transport issues.

Farmers' proposed solutions to constraints were:

1. More trial groups needed
2. Should organise transport themselves
3. Poultry farmer dumps manure half way
4. Storage in trench or shed or covered with plastic sheet or palm fronds
5. Use group's power tiller for transport

Given the farmers' pre-occupation with transport of poultry manure, the first ranked response was very curious. The author of the report (NRI, 2000b) raised the possibility that this apparent desire for more experiments was possibly so that farmers could obtain more free (delivered) manure, rather than the altruistic motive of introducing it to other farmers. The author also suggested that some of the responses were those of the extension officers' rather than farmers. Overall, the author displayed little confidence in the objectivity of the extension officers involved. The final event was a workshop which brought together poultry and crop farmers to discuss problems of utilisation of poultry manure. 34 farmers (numbers not broken down into poultry and crop farmers), 31 MOFA staff, three researchers and a representative of GOAN were present. The participants split into groups to discuss various constraints. It was suggested that (no ranking):

- Farmers should form groups to cart manure in larger quantities;
- Farmer should site field close to poultry farms wherever possible;
- Poultry farmers could consider subsidizing the cost of transport (as disposal is a considerable problems for them);
- There is a Village Infrastructure Project that could fund power tiller or donkey carts, but some footpaths would need to upgraded to accommodate these.
- Storage on a mat of plantain leaves, and coverage of the heap with palm fronds.

Uncertainly about objectivity of extension officers notwithstanding (which could be addressed by training), the report provided some valuable knowledge. It demonstrated that MOFA could mount a significant extension initiative involving large numbers of farmers, which is useful for any future projects to know. The work also tested an approach for dissemination of results, and it would be valuable to follow up the participating farmers to determine how many become long term adopters, and reasons for non-adoption. At the time of reporting, following the extension exercise, 320 farmers from 800 targeted had tried using poultry manure. Also, after the initial trials with household composting (consisting of household waste, poultry manure and wood ash), one year later there were 30 farmers still making and using the compost.

Note

[1] February 2000 exchange rate: £1.00 = 6,000 cedi (¢).

4 Livestock

Characteristics of major production systems in the peri-urban interface, Hubli-Dharwad

As explained in Chapter 1, as a city expands and increases the length of the interface, so the areas representative of 'urban' and 'peri-urban' increase. Land that earlier met the definition of 'peri-urban' becomes 'urban' and truly rural land now becomes 'peri-urban'. Although the remit of the original knowledge consolidation project was a peri-urban one, in this case it seemed appropriate to consider livestock production systems in both 'urban' and 'peri-urban' zones, in order to understand how the degree of urbanisation influences animal enterprises through and across the 'interface'. Unfortunately, most information available from project documents related to the urban environment and contrasts with the peri-urban were difficult to establish.

Cattle and Buffalo

Caveat

These animals occupy a very special position in India and their importance to Hindu culture cannot be over emphasised. Cattle and buffalo are regarded as sacred and this single fact certainly accounts for the tolerance shown by the majority of inhabitants to the presence of free-ranging animals in urban and peri-urban areas. The treatment of cattle is seldom seen and acts of kindness, such as the provision of feed, are believed to reflect favourably on the benefactor. This strongly held religious belief is unlikely to be challenged in the immediate future and underpins the relationship between man and the animal in all respects.

It follows that any attempt to analyse production systems for cattle and buffalo must take account of this special relationship and to ignore it runs the risk of offending the sensibilities of the vast majority of the people.

Having said that, analysis of current production systems in purely practical, economic terms can still be carried out and the outcomes of such exercises weighed against alternative approaches that might be possible if the animals were not so highly regarded.

General observations

There appears to be adequate information on the systems of production employed in the Hubli-Dharwad urban and peri-urban areas, which closely follow those found in other city areas in India. Indeed, the husbandry of these animals resembles that of a typical Indian village in many ways. In contrast, the scale of production in terms of the animal population and their production of milk (beef will not be considered for obvious reasons) has not been clearly established. In this section on cattle and buffalo, the principal source of information is Khan and Mulla (1997) unless otherwise stated.

Husbandry

Milk production units in Hubli-Dharwad range in size from those with 10-20 local or crossbred cows and/or buffalo to units with 1-5 animals (Nunan, 2000). The contribution of dairy farming to household income is roughly proportional to herd-size. People of many castes and tribes keep cattle and buffalo, but particular mention must be made of the Gowlies (Nunan, 2000), who have a long tradition of keeping milking animals, especially buffalo. Cattle breeds represented are a nondescript local type and crossbreeds, which have Deoni, Jersey or Holstein-Friesian blood. The breed of buffalo kept by the Gowlies is the Pandarpuri (alias Dharwari), others keepers have a Surti type.

The health status of mature animals with respect to the major endemic diseases (Foot and Mouth, Haemorrhagic Septicaemia and Blackquarter) is said to be satisfactory as owners have access to vaccination services, but mortality among young stock is high.

The feeding of animals follows typical Indian practice. Among free-ranging animals, especially those within the urban zone, part of their intake is found by foraging on vegetable wastes or as 'handouts' from those anxious to please the gods. Owners supply crop residues after harvest (e.g. sorghum stalks, rice straw) and grass in the rainy season on a cut-and-carry basis. Domestic vegetable waste is also supplied, as is waste from hotels and restaurants. Little compound is used, but straights such as groundnut cake, cotton seed cake, rice bran and horse gram are given in limited amount. Access to grazing is limited within the city but increases as the peri-urban area is approached and occurs on common land and wasteland during the rainy season. Only the larger and better-organised units grow forage crops for their animals in the peri-urban zone and in rural areas.

Animals are hand-milked, often by women, and marketing takes several different forms, as detailed in the section on liquid milk marketing below. Milk yields quoted by Khan and Mulla (1997), which seem somewhat optimistic, are as follows:

> Local cattle: 1200-1800 kg/lactation
> Crossbreeds: 5000-6000 kg/lactation
> Jandarpuri buffalo: 1200-1800 kg/lactation
> Surti buffalo: 600-800 kg/lactation

There is considerable variation in yield between seasons, much higher yields are obtained in the rainy season than in the dry season, but this too it typical of India as a whole (University of Birmingham *et al.,* 1998b, p.56).

Cattle and buffalo numbers

Information given in the project reports on animal numbers is not consistent. Thus Khan and Mulla (1997) present the following table:

Particulars	Cross bred	Local cows	Buffaloes	Total milch cattle
Rural Dharwad	13000	132500	138300	283800
Urban Dharwad	29000	12600	18400	33800
Hubli-Dharwad City	1000	3300	6100	10400
Dharwad Total	15900	145100	156700	317700

These figures do not reconcile across rows for Urban Dharwad or for each of the columns.

Figures presented by Nunan (2000) are for the Hubli-Dharwad City in 1997/98:

Animal	Total for 1997/98
Local cattle	8815
Crossbred cattle	655
Buffalo	6949
Total	16419

The only (tentative) conclusion it is possible to reach is that there are 10,000 to 16,000 animals in the city and rather more in the peri-urban area.

Given the difficulty of deciding when the urban become peri-urban and the peri-urban becomes rural, the exactness of the figures scarcely matters.

Liquid milk marketing

There are several channels for the marketing of liquid milk, but the volume passing through each of them cannot be established from project reports consulted. Consequently it is not possible to judge the size of the milk market in the city.

For dairy units in the urban area, marketing follows the following channels (Khan and Mulla, 1997; Nunan, 2000):

- Some of the larger dairy farmers market branded milk in half- or one-litre sachets through delivery boys.
- Urban Gowlies have established bulk outlets with hotels and boarding houses, which take a proportion of their production.
- Urban Gowlies also supply households through deliverymen who carry small churns from house to house. The opportunity for adulteration is clearly present!
- Some milk is supplied direct from the cow, which is driven from house to house for milking, thus obviating the risk of adulteration. In other cases animals congregate at a fixed place twice a day and customers call to purchase milk taken directly from the cow.
- There are milk vendors who do not own animals. These collect milk from producers, pool it and distribute through small outlets, of which there 40-50 in the city.
- Hubli-Dharwad has one large-scale milk processing plant, operated by the Karnataka Milk Federation (KMF) which has the capacity to separate milk, make butter and ghee, pasteurise, make whole and skimmed milk powders and prepare a range of fermented milk products. The background to the KMF and the organisation of its marketing mechanisms are described in (University of Birmingham, *et al.,* 1998b, p. 55). Standardised milk with 3% fat is sold through its agents and up to 110,000 litres is sold daily in this way. It is not clear from the reports what proportion of the output derives from urban or peri-urban sources of milk, but it cannot be very large, most coming from the truly rural zone.

Milk produced in the rural zone, and presumably from some units within the peri-urban zone, follows similar paths, with two important additions:

- The Dairy Co-operative Societies operating at village level buy milk from both members and non-members on a fat/SNF basis. This milk passes to:
- Large creameries such as the KMF, some situated up to 150 km from the city, which package branded milk and market through agencies in the city or supply it direct to larger customers .

As might be expected there appears to be considerable variation in the quality and keeping qualities of liquid milk. The practice of milking in front of the customer, which at least ensures freshness, has been referred to. Milk produced by the KMF and others with the ability to pasteurise will have an extended shelf life and be free of a number of infective organisms. Non-pasteurised, pooled milk, especially that sold from churns is likely to be of low quality and go sour very quickly. It should be noted that the Indian Milk and Milk Products Order (MMPO) for the regulation of milk quality standards does not apply to units handling less than 10,000 litres daily.

Milk products

There are a variety of milk products produced by KMF, including butter and ghee from cream after separation, whole milk powder, skim milk powder and lassi (buttermilk). Some skim milk is converted into curd and shreekand (a flavoured, sweetened curd). Two ice cream factories in the city purchase cream and skim milk.

Manure and waste

Urban dairymen may have problems in storing manure but they have no trouble in disposing of it. The manure finds two uses, either as fuel cakes, which fetch Rs15-20 for 100 cakes, or as fertiliser. Farmyard manure (FYM) is sold periodically to landowners at around Rs. 250-300 per tonne, or it may be exchanged for forage (Sinde and Joshi, 1997; Subhas, 1997). In the peri-urban area, those owning land use FYM on their own fields.

Slaughterhouse waste is collected from the abattoir and transported to HDMC pits at the dumping grounds. At auction the material fetches a higher price than general refuse, around Rs. 1,700 to 2,200 per pit (Subhas, 1997).

Pigs

Unless otherwise stated, information for this section was obtained from Khan and Mulla (1997).

Numbers and breeds

The pigs of Hubli-Dharwad are predominantly of the local type (Desi) and there does not appear to have been much crossbreeding with 'exotics' such as the Landrace, Large White or Tamworth. The animal is small, black and active and a very good scavenger, through by international standards its performance is poor. All that can be said about numbers is that there are very many! The official figure, quoted by Nunan (2000) is 839 in 1990, but she believes a more realistic figure is around 20,000 in the city. The discrepancy appears to be due to the fact that owners are reluctant or unable to give good estimates of the animals in their possession. For example, they may be unwilling to reveal their financial status to the authorities.

Husbandry

It is important to understand that the pig as well as the cow is revered in India. According to Hindu mythology the pig is considered to be an 'avatar', i.e. an Incarnation of the Lord Vishnu, the boar being one of the Ten Revered Incarnations (Ghatnekar, 1981).

Within the city, pigs are owned by the lower castes and by members of scheduled tribes, many of whom reside in distinct communities. As with buffalo, there is a tradition of keeping pigs, handed down within the family (Nunan, 2000).

In Hubli-Dharwad, pigs are not 'farmed' in the Western sense of the word and little effort has been made to control breeding, provide veterinary attention or care for the animals between birth and slaughter. The pigs are free to roam the streets and scavenge for feed, though in some instances food wastes are collected and given to them (Nunan, 2000).

This system has undoubted advantages:

- Low husbandry costs, principally arising from the low cost of feeding.
- Low capital costs, as permanent housing is not provided.
- Pigs remove refuse and litter from the streets.

In combination, these factors account for the profitability of pig husbandry in the area, even though the performance of individual animals is low compared to exotic breeds. For example, Ghatnekar (1981) reports the following results (Table 4.1) for Desi and 'exotic' pigs under Indian conditions:

Table 4.1. A comparison of Desi and 'exotic' pigs

Characteristic	Country Pigs (Desi)	Exotic Pigs
Adult body weight (kg)	80-120	200-255
Number born per litter	6-8	8-11
Number of piglets weaned at 2-3 months	4-6	6-8
Growing period (months)	9-12	7-9
Weight at slaughter (kg)	40-50	80-100
Feed:Gain ratio	6:1	3:1
Dressing percentage	60	80
Age at puberty (months)	18	9-12
Farrowing interval (months)	12-18	8-9

These results were obtained under housed conditions and it is unlikely that the 'exotics' would have performed so well on the streets of the city; the Desi is well adapted to its street-wise role. However, the pig has its detractors.

Marketing of pigs

Pig-meat is eaten by only some of the peoples of India and it would appear that the numbers produced in and around Hubli-Dharwad are more than enough to satisfy local demand as many are exported to Goa and to other cities in Karnataka. Animals are sold on a live-weight and dead-weight basis, at Rs. 15-20 and Rs. 35-50 per kg respectively (Nunan, 2000). The Christmas period is the busiest for trade, presumably because Goan Christians are happy to eat pork over the festive period. Pigs' bristles are used for brush making, but this was not considered in the reports consulted.

Manure

As pigs roam the streets and are seldom confined to pens, the opportunity to collect their manure is small. However, they serve the useful purpose of consuming all sorts of refuse, even though they foul the streets and are seen as a threat to health for this and other reasons (see below) (Subhas, 1997).

Poultry

The project reports consulted have little to say about poultry production, both for eggs and meat. This is hardly surprising, as apart from the backyard

hen, production is in the hands of relatively well developed producers with broiler capacities of between 100 to 2,500 birds per week and layer units having 1,000 to 10,000 birds (Khan and Mulla, 1997). In general, such units are well run and follow standard Western practice. Large-scale poultry farmers are presumably well off, having the necessary capital to set up their enterprises. Poultry manure is prized and is used for horticultural purposes (Khan and Mulla, 1997; Subhas, 1997; Sindhe and Joshi, 1997. As bird are not centrally slaughtered but sold to shops where they are killed, there is no great concentration of offal and feathers at any one site. Such material is handled along with other refuse (Subhas, 1997).

It would seem best to leave this sector to its own devices. The following changes can be anticipated, brought about by increasing Western influence:

- A decline in the sale of live-birds for the table.

- An increase in frozen and chilled-bird sales.

- Increasing acceptance of brand names

- Under the aegis of the GATT/WTO, expansion of fast food outlets in Indian cities e.g. KFC and McDonalds (see Starchik Corporate file at www.starchik.com).

No doubt the backyard hen will survive, to provide a few eggs and meat for special occasions. There is no mention of ducks in the reports though there must be some about.

Sheep and goats (shoats)

Unless stated otherwise, information for this section has com from Khan and Mulla (1997). These animals are kept in the outskirts of the cities and according to official figures the number of sheep has risen from 558 in 1990 to 1,888 in 1997/98. In contrast, goats have declined from 4,139 to 3,683 in the same period (Nunan, 2000).

Animals are kept for milk and meat, and are often owned by people originally from rural areas. There is no information on the sheep-owners, other than that they includes Gowlie families (Nunan, 2000). They are cared for by women (and children) and are sold direct to customers. Sheep, being grazers, face increasing shortages of pasture, while goats, which browse, can be maintained on harvested tree material (Nunan, 2000, p.19). There were reported to be '5 or 6 organised sheep farms' (Khan and Mulla, 1997) in the Hubli-

Dharwad area, some of which have floated 'sheep bond schemes'. The significance of these schemes is not clear. Sheep penning on harvested arable land is practised the animals' dung adding to soil fertility. Manure collected from homesteads is sold for around Rs200-300 per tractor load (Nunan, 2000).

Changes to production systems due to urban development pressures

Cattle and buffalo

Types of urban pressure

Increasing urbanisation is associated with pressure on city milk producers that take several forms. These include:

- The presence of cattle on the streets will not be tolerated and that the Supreme Court Interim Report of 1998 will be acted upon (Nunan, 2000).
- Increasing distances over which livestock forage and manure must be carried, in turn associated with increased transport costs.
- Increasing distance between dairy sites and grazing lands in the peri-urban zone.
- Reduction in the availability of grazing areas within the city due to building.
- Increasing risk that roaming animals may ingest harmful items (Nunan, 2000).
- Increase in traffic volume, such that wandering animals present a greater threat to the flow of vehicles (Nunan, 2000).
- Greater intolerance by an increasingly urbanised population to the smells arising from the storage of manure.

Of these seven points the last three are self-explanatory; the first three merit amplification.

Supreme Court Interim Report

Among the recommendations of this report on improving solid waste management in cities was the following relating to cattle.

" No stray cattle should be allowed in cities above 5 lakh (500,000) population. All existing cattle sheds, vadas and go-shalas should be removed in a phased manner from such cities. Until then no animals should be allowed to move around the streets. They should be stall-fed and the waste produced in such stables should be disposed of by the cattle owners on a daily basis at the

community storage sites. Owners of these animals should be suitably charged for the disposal of such trade waste in the municipal system."

The report goes on the recommend the phasing-out of stall-fed milk production in the cities. It is probable that the Supreme Court based its decision on the final two points in the above list for it refers to cattle as a 'nuisance'. If this proposal were implemented, and if it applied to buffalo as well as cattle, then this would be the end of the urban dairy in India.

Transport costs for feed and manure

There are two practical advantages from the keeping milk-producing animals in and close to the city centre. Firstly, there is no delay between milking and purchase, so ensuring freshness; secondly, no opportunity arises for adulteration when animals are milked in the presence of the customer.

In Britain, the first of these advantages applied up to the early years of the 1900's but with the development of the railway system the 'city dairy' fell into a gradual decline. The practice of milking in front of the customer was not followed in Britain, but the law was strictly enforced whenever adulteration was detected. This certainly did not ensure that milk was never watered-down, neither did it mean that high-quality milk was supplied at all times. Indeed, milk quality issues were a major concern at the time and local authorities increasingly took steps to improve the housing of cattle and the quality of milk. The introduction of the tuberculin test and checks on total bacterial count, Coliform organisms, keeping quality and the classification of milk (Grade A. standard) contributed to the improvement in quality. Further improvements can be attributed to the phased eradication of bovine tuberculosis in the national herd and in recent years to compulsory pasteurisation.

The fate of the British city-dairy was essentially decided on economic grounds. It simply became too expensive to import feed for the animals from rural areas. With the coming of the railways and other forms of improved transport, improved milk handling and cooling, it was much cheaper to import milk than feed. It seems likely that as Hubli-Dharwad expands this will be true of that city. Further, dung produced in the city has to be carted to the field when it is used as a fertiliser and while it has commercial worth, there must be a cost of transport that reduces its value below that it would command if it were produced where it was needed. However, as long as milk produced in the rural areas is distributed in unhygienic fashion, and as long as the populace prefers 'milk fresh from the cow' the urban and peri-urban milk producer may well prevail.

It can be calculated that not less than 2 kg of feed and solid excreta must be transported for each kilogram of milk produced, and this figure applies for high yielding animals on nutrient rich diets. In Hubli-Dharwad a high proportion of animals in the dairy units are not producing. A case study reported by Nunan (2000) suggested that at any one time only a modest proportion of the animals are in milk and this exacerbates the problem. It is expensive enough in time and money to feed a cow that produces milk; the cost of feeding unproductive animals for no return, hard to justify. It should be noted that in Britain, city dairy-farmers kept 'flying herds', i.e. recently calved cows (or in-calf animals that were due to calve in a few weeks time) were bought, milked and then sold at the end of their lactation, to be replaced by new, productive animals. How this system would marry with the Hindu attitude to the cow is hard to predict.

The problem of the dry cow is of course a universal one, but is especially acute in tropical countries, where puberty is later and inter-calving intervals much longer than in temperate countries. Even in the rural area it will remain a problem, as has been shown by van den Ende (1999) in a study of dairy production in rural Orissa. Some of his conclusions are shown below:

". . .it is clear that the hybrid 'Jersi' (crossbred Jersey) cows produced considerably more milk than the domestic breeds.

. . . best margins of sales over feed costs were achieved by herd owners with smaller herds, fewer unproductive cows and those whose 'Jersi' cows were in milk for the greater part of the recording programme.

All cows, whether in milk or dry, received similar rations. Failure to target better rations at the higher yielding crossbred cows is clearly counterproductive. When this was raised for discussion, it was forcefully stated that cows are kept not only for their milk, but also for religious and sentimental reasons. 'We have a duty to feed all our cattle. Cows are close to God and if we neglect them, other people will notice'. (Son of Pali Bahera, participant No. 13). The concept of maximising profit was not paramount."

It is interesting to note than van den Ende (1999) found that only two of the twenty herds studied produced milk of greater value than the cost of feed-stuffs supplied to the animals. Losses of up to 86% of the cost of feed were recorded, while one of the two profitable units made a profit of 60%. This should not be taken as indicating that dairy farming *per se* is generally unprofitable, as the cattle and buffalo he studied were also used for traction and it was not possible to separate the cost of feeding the cows from that of the herd as a whole. However,

it does illustrate the impact that dry animals can make on the economics of dairying.

Grazing land

The City has a relatively high proportion of its land set aside for recreational purposes and there is even some ground that is used for crop production. These areas are used for grazing and for exercise after harvest. However, most animals are taken to the surrounding 'green belt' lands to graze in the rainy season (Khan and Mulla, 1997).

Open land within the city is under increasing pressure from developers and as the city expands, so those within the urban area are forced to drive their animals over greater and greater distances in search of grazing. This is expensive of time and energy.

Pigs

The pigs of Hubli-Dharwad are seen by many as a nuisance, for the much the same reasons, as free-ranging cattle are disliked, e.g.:

- Pigs are a hazard to traffic, especially cyclists and motorcyclists.
- They are believed to carry communicable diseases.
- They raid gardens and cropped land.

With regard to health hazards, there is no doubt that improperly cooked pork can lead to *Taenia solium* cysticercosis, as can contact with infected animals. Another potential hazard is that of Japanese encephalitis, which is transmitted by certain mosquitoes (*Anopheles* sp. and *Culex* sp. principally) between man and pigs. Because there are no extensive areas of still water in which the mosquito can breed, there are only small populations of these insects in the city, so risk of disease is not high. However, the perception of risk persists.

The HDMC has been trying to evict pigs from the city for about 10 years, in response to complaints about their nuisance value. Following publication of a notice in the papers, they are rounded up and taken out of the city to woodlands about 10 km away. The future of the pig may well rest on the energy with which the Corporation pursues this policy, (Nunan, 2000).

The alternative of keeping the animals in yards or pigsties carries with it cost implications for the farmer in the shape of capital for housing and increased running costs in procuring and carrying feed to the animals. Farmers believe that this would be too high a price to pay and that the Desi would not thrive under

such conditions. An alternative would be to introduce exotic breeds and educate the farmers in their management.

Characteristics of principal stakeholders

Cattle and buffalo

In the milk-production sector, the principal stakeholders are the farmers, their customers, those producing the forage and waste vegetable material consumed by the animals and the people who buy dung cakes or manure. Viewed from a farming systems standpoint, other interested parties are those intent on the development of the properties presently occupied by the cattlemen and the land within the city and its surrounds that is currently used for grazing.

The characteristics of the farmers, in terms of their numbers, caste, traditions, division of labour between the two sexes etc. appears to be adequately understood, but there is little or no information about other actors. There is considerable variation in the characteristics of the dairy farmers, especially in the size of their herds and the reliance they place on milk production as a source of income. In consequence, livelihood strategies range from total to marginal reliance on milk production as a source of income. Those with small herds undertake a range of manual jobs, including labouring, metal work and domestic service (Nunan, 2000).

It is not clear from the information available what the wealth ranking of dairy farmers is and this is a serious omission.

Pigs

Project reports provide a partial picture of the characteristics of pig-keepers in and around Dubli-Dharwad. Thus their location (Malmaddi, Saraswatpur, Hossallapur, Old Hubli, Settlement Area, Keswapur), ethnicity, livelihood practices and customs have been adequately established. Once again, the wealth-ranking of these people is not adequately identified, through it would seem that at least some are rich, as they are able to employ workers and equip them with motorcycles to look after the animals (Nunan, 2000).

Livelihood strategies of poor households

It is not possible to come to any conclusions about the livelihood strategies of poor households in the peri-urban area simply because there is no information on these at all. Animal husbandry practices are likely to be the same as in rural areas of Karnataka and other parts of India but this is not spelt out. The correlation between livestock ownership and wealth, even in the urban area, is not very clear. Presumably those families that own few animals are less well off and may fall into the poverty stratum, members of the family may have to pick rags and undertake other menial work, but their financial status and well-being have not been characterised.

The effects upon the poor of changes to the PUI land use driven by urban development, strategy options and interventions

The future of livestock production in Hubli-Dharwad city and the livelihood strategies of livestock owners would seem to rest on the balance between two opposing forces, which apply to rich and poor alike. On the one hand there is the efficient utilisation of organic wastes generated within the city and immediate access to markets, plus the provision of nutritious food for the rich and poor of the area. Another important factor on the side of the city farmer is 'tradition' and the significance of this should not be underestimated. On the other hand there is the increasing cost of transporting supplementary feed from the rural surrounds, of carrying manure to the field, the nuisance value and the perceived disease-risk presented by the animals.

Official policy is on the side of those against urban (and to a degree, peri-urban) livestock-keeping and to oppose it would seem to be most high-handed. However, this does not mean that future project activities should actively support the policy of eliminating urban livestock farming or focus on the formulation of strategies to achieve this end. A neutral stance would seem to be the best option, one that allows the existing forces to run their course.

The forces against animal keeping in the city are represented by legislative actions, (a consequence of increasing road traffic congestion), the dislike of the general public of middens near their homes and the perceived risk of disease. Adding to these are the economic forces, arising from declining availability of grazing areas within reach, transport costs and the growing acceptance of

branded foods of higher quality from the large co-operative dairies, poultry units etc.

It seems inevitable that, over time, the animal will leave the city and this will mean that major changes in the lifestyle of farmers that are forced to abandon their businesses will come about. When this will happen is hard to predict. Whenever it happens, the municipal corporation will be faced with the problem of disposing of a larger amount of organic waste than at present. This suggests that future project activities could be directed to alternative uses of this organic waste.

Assuming that cattle are evicted from the city in the fullness of time, something should be done about the KMF Dharwad. This branch is not serving its clients well and has shown a market decline in milk procurement from the peak of 1992/3. Other branches in Belgaum and Bangalore work well and a consultancy to sort out the Dharwad branch's problems seems to be called for (University of Agricultural Sciences, 1997, p.56).

For sheep, goats and pigs a number of group schemes have been tried elsewhere in rural India (e.g. Kribhco East, DFID Contract No. 943431), which have had modest success among the rural poor. The formulation of policy options to be tested in pilot projects will focus on a specific sub-set of poor households, whose production figures and livelihood practices must be established prior to project initiation. This appears not yet to have been done. Factors affecting the outcome of group livestock-husbandry initiatives are the usual ones, i.e. assured fodder supply, provision of preventative medicines, effective marketing and equable distribution of responsibilities and benefits among participants.

Also, links between the community and the governmental agencies providing support services (extension, veterinary, credit) should be fostered and people made aware of what can be provided by these agencies. Finally, training courses for key personnel may be needed, depending on the nature of the initiatives undertaken.

Characteristics of major production systems in the peri-urban interface around Kumasi

Animal ownership and numbers of stock in the peri-urban villages

In order to obtain some idea of the importance of various animal enterprises in the peri-urban area it is necessary to estimate the pattern of ownership and total numbers. There is no information on the numbers of any species for the peri-urban area around Hubli-Dharwad. For Kumasi, there are three important sources of this information, as explained below.

Firstly, a survey of seven peri-urban and one rural village (Kasanga, 1998, p.94, 102-105), in which 320 females and 160 males were questioned yielded the results shown in Table 4.2.

Table 4.2. Ownership of livestock in the Kumasi peri-urban area

Question	Yes		Total
Sex	F	M	
No. of respondents	320	160	480
Is your major occupation farming?	130	47	177
Do you own livestock?	128	66	194
Do you own cattle?	0	2	2 (1%)
Do you own goats?	13	12	25 (14%)
Do you own sheep?	33	22	55 (31%)
Do you own poultry?	125	54	179 (101%)
Do you own pigs?	1	2	3 (2%)
Do you own any other livestock?	0	0	0
Total owning specified livestock	172	92	264

The discrepancy between those who claimed to own livestock and the total number of men and women who replied 'yes' to the questions about individual species ownership may be because poultry are sometimes regarded as not being 'livestock' and/or because some owned more than one species.

One hundred and thirty women and 47 men, a total of 177, stated that their primary occupation was farming. If it is assumed that these people owned the cattle, sheep, goats and pigs (ownership of poultry is likely to be more general), it is possible to calculate the percentage ownership of these species among the farming community. Figures from Kasanga (1998) are shown in bold in Table 4.3.

Table 4.3. Number of villages in which certain proportions of villagers keep different livestock types

Class	Pro-portion	Sheep		Goats		Pigs		Cattle	
		No. (%)	Owner ship (%)	No. (%)	Owner Ship (%)	No. (%)	Owner Ship (%)	No. (%)	Owner ship (%)
None	0	5 (8)	0	32 (49)	0	51 (78)	0	46 (70)	0
Some	0.10	33 (50)	5	21 (32)	3.2	15 (22)	2.3	20 (30)	3
About half	0.50	23 (35)	17	11 (17)	8.4	0 (0)	0	0 (0)	0
Most	0.80	5 (8)	6	2 (3)	2.4	0 (0)	0	0 (0)	0
Al-most all	0.95	0 (0)	0	0 (0)	0	0 (0)	0	0 (0)	0
			28.5		14.0		2.3		3.0

Notes: Class = classification as shown in Kindness (1999, p. 12)

Proportion = assumed proportion corresponding to class

It is clear that cattle and pigs are not widely owned, and that sheep and goats are the most important species in this respect. Confirmation of this picture is provided by (Kindness, 1999, p.12), where the information shown in Table 4.3 is presented, gathered from 66 villages in the peri-urban village characterisation survey reported in (Blake *et al*., 1997a).

The agreement between the two sets of figures is good, i.e. around 1-3% of farmers own cattle, 2-3% own pigs, 14% own goats and 28-31% own sheep. The

size of the herds and flocks is also indicated in (Kasanga, 1998, p.102-104), which shows that the modal numbers of cattle, sheep, goats, pigs and poultry were about 21-25, 6-10, 1-5 and 6-10 respectively. In general, therefore, the numbers of animals owned by individuals is not great, though there are some larger units. Thus 6 or 7 large-scale poultry farms and one sheep unit of 26-30 animals were encountered. It is also important to note that in many peri-urban villages, goats are banned, because of the damage they do to crops (Holland *et al*., 1996b, p.43, 60, 75, 109).

Regarding the total numbers of animals in the peri-urban zone, Kindness (Kindness, 1999, p.12) made a rough estimate by multiplying the livestock census figures for the Ashanti region by the proportion of land lying within the Kumasi peri-urban zone, which was thought to be about 0.3. The resulting figures, which must include the KMA as well as the peri-urban, are shown in Table 4.4.

Table 4.4. Estimated numbers of livestock in the Kumasi area for 1996

Cattle	Sheep	Goats	Pigs	Poultry
6,500	72,022	55,482	5,706	686,052

Tentative conclusions can be reached; there are about twice as many cattle in the KMA area as there are in the peri-urban zone, about four times as many pigs and there are considerably more sheep and goats in the peri-urban area than the city.

Cattle

General observations

Cattle in the Kumasi area occupy a very different position to that at Hubli-Dharwad, as there is no religious constraint to beef eating. Indeed it can be said that the Ghanaian is essentially a meat-eater. In contrast, many Ashanti do not drink fresh milk. This may be due to their intolerance to milk constituents, particularly lactose, which is genetically determined and at a high level in certain African peoples. Unless stated otherwise, information for this section has been obtained from Akyeasi (1999).

Most of the information summarised below on cattle relates to the urban situation and there is practically none that is definitely peri-urban. Observations on both situations are included in this chapter.

Characteristics of cattle production systems

Most information was obtained on urban systems, and these will be considered first. With regard to diseases, there is a mixed approach to the control of major epidemic diseases such as rinderpest and foot and mouth disease. Survey results gathered from 45 cattle keepers in the city revealed that about half (49%) practised vaccination, 18% knew the importance of sanitation and followed sanitary practices and 38% treated symptoms as they arose (Akyeasi, 1999). Nearly all of the respondents sought veterinary advice when an animal fell sick, but not all farmers were confident of the expertise of the vets consulted. The major diseases appear not to be widespread, for only about one-fifth of the farmers said they had had trouble in the past. However, about two-thirds reported outbreaks of a skin disease affecting genitals and the udder. An important feature of cattle keeping in the city is that there is no trypanosomiasis there as the vector, the tsetse fly (*Glossina* spp.), needs bush country in which to reproduce.

Cattle are kept at night in kraals in most cases, but there are instances of housing and of tethering near the homestead. By day most animals are taken-out to graze, either under the eye of a herdsman or tethered. Zero grazing is practiced by some and the general picture on feeding practice is summarised in Table 4.5.

Table 4.5. Feeding practices for cattle in Kumasi

Basic practice	Frequency	Source of carried feed (Percent respondents)
Pasture grazing	53%	Not applicable
Stall feeding plus grazing	29%	Grass (47%)
Tethered grazing plus feeding	9%	Household waste (49%)
Stall feeding	9%	Spent grain and maize bran (9%)

Source: Akyeasi (1999).

The main household wastes used are cassava and plantain peels, taken from the home and from the many 'chop bars' in the city. Cut grass comes from undeveloped land and grazing can be found at specific locations (Buokrom Estate, Sepe-Antoa roadside, Sepe-Timpuon, Nakwadwom, Tafo Nhyiaso and the Kronom-Kodie roadside). On average animals are driven 3 km/day to grazing sites and have a 3 km walk to the kraal. The majority of owners think that grazing is plentiful or moderately available and only 9% believe it to be scarce.

Cattle ownership is so restricted in the peri-urban area that it is not surprising that no information on husbandry systems is to be found in project reports. In the peri-urban zone, the Fulani cattle herders from the north are present (Blake *et al.*, 1997a, p.47; Holland *et al.*, 1996a, p.48) and it can be assumed that their practices follow traditional lines.

Numbers and breeds

It is difficult to estimate the number of cattle kept in the KMA area. However, Akyeasi (quoted in Critchley, 1998, p.22) gives the composition of a typical herd as established from his survey data and estimates the number of 'regular' cattle-keepers to be about 500. He also mentions that there may be as many as 2,000 speculators who keep cattle for short periods (3-10 months) in the city. Assuming that the typical herd corresponds to his survey results (5 bulls, 10 cows, 3 young bulls and 5 heifers; total 23) then there must be not less than 11,500 animals at any one time in the hands of 'regular' farmers and many more owned by speculators.

Survey results suggest that about half the animals are of the West African Shorthorn breed, with roughly equal representation from the N'dama and Zebu/Sanga for the balance. New breeding animals are obtained from several sources, most (69%) coming from the Kumasi abattoir! The abattoir must be rather more than a slaughterhouse. It imports animals from other parts of Ghana, presumably for sale as well as slaughter.

Marketing

Milk: Even though lactose intolerance is prevalent in Ghana, there is still a demand for fresh milk and milk products. Most cattle owners (73%) milk their cows but only half of them used the milk at home. In most cases, herdsmen in charge of animals carry out milking and the sale of this milk represents their daily wage. Milk is processed into 'wagashi' (cheese) and 'noonah' (yoghurt) and both these products would have much-reduced lactose content. There is nonetheless a good market for fresh milk, as evidenced by the ease with which the local university farm sells its daily production.

Meat: Animals for slaughter mostly pass through the city abattoir and only about a quarter are sold on the hoof at the kraal or homestead. Major purchasers of meat are the 'chop bar', of which there are many in Kumasi. Consumption of

meat among the cattle owners is high, averaging more than 20 kg per family each week.

Manure

Little use is made of manure and in most cases it is simply thrown away. Some respondents made use of it on their fields and there is limited appreciation of its worth as a soil conditioner and fertiliser in urban and peri-urban areas (Holland *et al.*, 1996b, pp.31, 44, 61, 93, 110

Pigs

General observations

Unless otherwise stated, the source of information about pigs in Kumasi is Anyinadu (1999). In general terms, pig keeping in Kumasi City appears to be profitable and owners are contented with their enterprises. There is, however, considerable pressure of them to move out of central locations to the peri-urban zone at nearest. This pressure comes from the local authority and is a continuation of the process that has already led to the housing of pigs and the introduction of exotic breeds over the past twenty-five years or so.

Characteristics of pig production systems

As was reported for cattle, there are few pigs in the peri-urban zone and little information on their husbandry (Holland *et al.*, 1996a, p.46). Therefore, most of what follows is relevant for urban systems. Though they are present in Ghana, the reports consulted make no mention of vaccination against erysipelas, foot and mouth disease, etc. However, survey results show that most pig keepers take veterinary precautions involving the use of worming agents, antiseptics and insecticides. In common with most small-scale producers throughout the world, they are not heavy users of professional veterinary services, preferring to carry out their own diagnosis and the advice of the local pharmacist. Professional services and drugs are thought to be very expensive.

It seems likely that the small scale of their operations and the dispersed location of the piggeries protect the farmers from the threat of widespread disease. However, some 40% are to be found in Nakwa Dwom and this location must be at greater risk than others.

All the pigs recorded during the R6799 inception phase were Large Whites originating from European stock and there were no Ashanti (Dwarf) Blacks, the

local strain of the widely distributed West African breed. This breed is reputed to have a degree of typanotolerance, but this would not be a necessary trait for housed animals kept in an urban environment.

Most breeding animals are bought from other farmers in the KMA area, the UST or the Ghana Livestock Research Station near Accra. The extent of breeding, as opposed to rearing of purchased weaners, is not clear from the information available nor is it possible to distinguish between the number of sows/gilts in Kumasi and the total number of pigs.

All animals are kept securely penned and are provided with shade. With regard to feeding, extensive use is made of various wastes and by-products. Among the by-products are bran (maize, wheat, rice) from the milling industry, brewers' grains and, to a limited extent, palm kernel and cotton seed cakes. The -kitchen provide peel from cassava, yam and plantain, and leaves of various fruits and vegetables. Fishmeal and by-products of the fishing industry are widely used. Farmers appreciate the need to supply a reasonable amount of good quality protein to their animals. In general most (68%) of respondents believed that the quality of the feed used was either good or satisfactory and they were satisfied with the animals' performance.

Advice on pig keeping is sought by about one-third of the farmers on a regular basis, one-third receive occasional advice and the remainder receive no advice at all. There is a general perception that the pig is considered unimportant by the MOFA.

Numbers

There appear to be about 100 pig units in the KMA area, but only 10 or so 'keep' 70-100 animals each year, the remainder 'keep' 2-60 per year. The modal number of animals kept by each farmer is 16, so there must be about 1,600 pigs (possible only sows and gilts, see above) in Kumasi at any one time.

Marketing

There is little problem in selling pigs in Kumasi to local traders. The animals are rarely slaughtered in the city as the abattoir is Muslim operated and only 4-5 pigs are killed there each day. Most animals are slaughtered 'within houses in the KMA area', which may mean at the home of the purchaser, or by the farmer him/herself. Most pig meat is consumed fresh and there are only a few sausage or meat loaf makers. Demand for processed pork is high and this area deserves more attention. Pig skins and bristles are not utilised in the city.

Most pig farmers (80%) think that production has increased over the past 20 years and will continue to do so; they attribute this in part to improved marketing. Possible barriers to enhanced production are the costs of feed and drugs and the space for piggeries.

Manure

There is little attempt to make effective use of pig manure in Kumasi. Survey results showed that only 45% of the respondents used it for gardening or made it those using the dung in this way disposed of part by throwing it away.

Poultry production systems

General observations

Poultry production around Kumasi has been described by Kwakuyi (1999) who concentrated on those producers maintaining units of a reasonably large scale and excluded 'backyard' poultry keeping. Consequently there is a dearth of information on the latter aspect and it is not possible to form any opinion on the importance of the 'backyard' bird to livelihood strategies and wellbeing. Her description of the units surveyed gives the impression that the larger poultry production units are organised along modern lines.

Poultry husbandry

Essential features of the poultry production are indicated in the Table 4.6. It is important to note that this table relates to the larger units surveyed by Kwakuyi (1999) which lay in the peri-urban area.

Poultry are widely owned in the peri-urban villages. Supplies are obtained from the city in many cases (Holland et al., 1996b, p. 29, 44, 60, 76, 110). A high proportion of the people keep a few birds each on a 'backyard' basis which are free to forage for feed, but no further information is presented. However it seems safe to assume that the birds lead the precarious existence typical of such birds throughout the world (Holland *et al*., 1996a, p. 47).

Numbers

There are not fewer than 92 poultry units in or close to the city. This figure was deduced from the membership lists maintained by local societies interested in poultry production, so it is very possible that there are many more, owned by non-members. The survey considered units ranging in size from less than 5,000

birds to those with more than 10,000. The distribution by unit size was as follows: Up to 5,000 birds: 14 units; 5,000 to 10,000 birds: 62 units; more than 10,000 birds: 16 units.

Table 4.6. Aspects of poultry husbandry in Kumasi

Aspect	Narrative summary	Reference
Type of unit	All the farm studies had layers and only about one-third had broiler units due to the general unpopularity of tender broiler meat and the seasonal nature of the broiler market.	Holland *et al.* (1996a, p. 46)
Breed of birds and sources	Breed not clear, but probably hybrid types purchased from hatcheries such as Darko Farms Ltd. Darko maintain a web site (www.darkofarms.com) which claims an annual production of 5 million day-old-chicks. They have a strong USA connection. Some larger producers have their own hatcheries, but parent stock not stated.	Holland *et al.* (1996a, p. 46)
Veterinary	Normal precautions taken against Newcastle disease, Gumboro and Coccidiosis by all farmers. Professional veterinary advice is sought in cases of disease outbreaks.	Holland *et al.* (1996a, p. 46)
Housing	Generally on deep litter (bedding material not stated in survey, but it is likely to be sawdust or wood shaving), see [R6448/02: 93]). Only 5% use battery cages, possibly due to the difficulty of handling moist manure from the cages.	Holland *et al.* (1996b, p. 93)
Feeding	Maize-based meals prepared by most and little compound feed is bought in. Wheat bran, fish meal and oyster shell (for Ca) used. All owners regard their feed as good or satisfactory.	Holland *et al.* (1996a, p. 46)

Marketing of eggs and birds

There are a number of channels for egg marketing. About 22.5% of farmers sell exclusively from the farm and 10% have their own outlets in the city. The most important marketing route is through traders, usually women, who buy the eggs and sell them retail. There are also wholesalers (Holland *et al*., 1996a, p. 46). Culled birds find a ready sale, either to customers calling at the farm or through market outlets. Prices seem to be good as the demand for poultry meat is

increasing. Peri-urban produce is either taken to Kumasi or is purchased by traders from the larger units (Holland *et al*., 1996b, p. 30,43).

Manure

City manure disposal is not well organised, possibly because there is no traditional use in crop production. However, most farmers make it available for horticulture, though some find that there is little call for the material and have to throw it away. In the peri-urban area 67% is reported to be used (Kindness, 1999) {e.g. Holland *et al*., 1996a, p.46; 1996b, p.31, 93, 110). Refer to Chapter 3.

Small ruminant production systems

General observations

Unless otherwise stated, information about sheep and goats (shoats) has been taken from Kwame (1999). As is often the case in Africa, both sheep and goats are managed similarly and so are considered jointly.

Sheep and goat husbandry

Table 4.7 provides a summary of sheep and goat husbandry in Kumasi Metropolitan Assembly (KMA).

Sheep and goats in the peri-urban villages are widely owned and a little information on their husbandry is available. They are mostly allowed free-range at all times, or they may be penned until taken out to graze under the eye of a shepherd in the afternoon. Of interest are the practices of imposing fines on owners that allow their animals to damage crops (Holland et al., 1996b, p. 60, 75, 109) and headage levies on stock (ibid, p. 60). Vegetable wastes and crop residues are again fed (ibid p. 43).

Numbers

The number of animals in Kumasi city has not been accurately estimated and the information summarised above was based on a survey conducted in four areas of the city, which were chosen on the basis that the shoat population there was known to be high. In these suburban areas the number of flock owners interviewed was 50 with an average flock size of about 10.

Table 4.7. Aspects of goat husbandry in Kumasi

Aspect	Narrative summary
Breeds	Sheep: 86% Djalonka (alias Djallonké or West African Dwarf), 14% others. Goats: 100% West African Dwarf.
Housing	88% in pens or in home compound, 12% within the house.
Feeding	All owners use household vegetable wastes, including that from 'chop bars'. Animals are grazed on undeveloped land and recreational areas. Also used are brewers grains, cut guinea grass and crop residues.
Veterinary	Diarrhoea is common, also ectoparasites. Veterinary help is called for when animals fall ill.
Sources of breeding stock	The majority of new animals come from local markets, but a few from further afield, depending on breed.
Problems	Diseases (as above), housing.

Source:Kwame (1999)

Marketing of sheep and goats

Most animals are sold on the hoof by barter, major customers being the numerous 'chop bars'. About 300 shoats are slaughtered at the abattoir daily. Meat retailers operate close to the abattoir and enjoy a good trade. The source of these animals was not stated in the report. The market for the animals is good and numbers are said to be increasing. The Revenue: Cost Ratio for stall-feeding: grazing: stall-feeding + grazing has been estimated as 1.4: 2.4: 1.9 per animal unit. Most of the profit (78%) goes to the owner of the animals. Neither sheep nor goats milk is marketed, though some owners, especially from the Sahelian countries may consume it themselves.

Manure and wool

No measures are taken to conserve manure for fertiliser purposes and there was no mention of wool in the reports consulted.

Small animal production systems

General observations

Rabbits, grass cutters, snails, bees and the giant rat are kept in the Kumasi urban area. Solomon (1999) who collected data from 19 urban locations provides information on these. As he interviewed only 21 respondents, i.e. about one per

village, it is possible that his finding may not be representative of Kumasi and its environs, unless a high degree of homogeneity exits between location and production system. On the other hand, it seems likely that systems of production for each species will vary greatly between units and it may be impossible to form a general picture of production methods.

Interpretation of his findings is difficult as his report contains several contradictory statements. For example, 'the standard of living of the (*small animal*) farmer is comparable with that of the average Ghanaian and to some extent a modest good living.' 'Generally, low income levels characterise small animal farmers with the exception of farmers with additional work such as the civil servants whose average income annually ranges from 1,900,000 cedis'.

One is left with the impression that small-animal keeping is a part-time activity for a range of people, including schoolchildren, professionals, artisans and those who farm in other ways on a full-time basis. Its importance to livelihoods is hard to judge, as it seems that the animals are kept as much for the pleasure they give as for food or sale. The scale of production is small, e.g. the average number of female rabbits kept was only 7, and no examples of large scale, intensive units such as are found in the West are reported in Solomon (1999).

Husbandry

Table 4.8 summarises key features of the husbandry systems employed.

Numbers

The total number of animals in the Kumasi urban and peri-urban areas appears not to have been established, but it is probably not very many.

Marketing

Animals are sold for meat and honey is produced. There is no processing of meat or honey other than some meat may be smoked prior to sale. Non-specific use of wax, shells etc is made. Solomon (1999) quotes the following prices:

Grass cutters 30,000 to 40,000 cedis; Rabbits 12,000 to 20,000 cedis; Bottle of honey 3,500 cedis; Three snails 1,000 cedis; Giant rat 5,000 cedis.

Manure

Manure is kept for home use in some cases. Other than this there is no indication of use, possibly a reflection of the small quantity available.

Table 4.8. Husbandry of small animals in Kumasi

Aspect	Narrative summary
Reasons for keeping	For cash and home use and for aesthetic reasons
Housing	Cages of one sort or another or in small enclosures.
Feeding	Crop residues, roots, vegetables and fruits, forage grasses, agricultural by products, household residues etc. are used.
Animal breeds	<u>Rabbits</u>: some exotic rabbits, e.g. new Zealand Whites and Flemish Giants are kept as well as a local type. <u>Grass cutters</u>: *Thryonomys swinderianus,* (indigenous) <u>Snails</u>: *Achatina achatina* and *Archachiatina marginata* (indigenous) <u>Bees</u>: *Apis mellifera adansonii* <u>Giant Rat</u>: *Cricetomys gambianus*
Veterinary	Diarrhoea, skin diseases and worm infestations are important.
Constraints on production	The most important appears to be lack of credit, which would enable keepers to provide better housing. Also mentioned by respondents was feeding, disease and technical knowledge.

Source: Solomon (1999)

Fish farming systems

General observations

The survey conducted by Agyapong (1999). of the urban and peri-urban areas of Kumasi was very thorough and provides a comprehensive account of current practices.

Husbandry

Table 4.9 provides a brief account of the principal features of fish-farming practices. Constraints to the expansion of fish farming include the high cost of feed and of transporting poultry manure, the non-availability of fingerlings and of some feed items, capital and credit (especially for pond construction).

Additionally, landowners are unwilling to rent land for pond construction, marketing is poor, the Fisheries Department is understaffed and there are instances of water shortages when pond are not supplied from permanent water courses.

Numbers

There are 94 fish farmers in and around Kumasi, managing 122 ponds, of which 38 provided information for the survey. In terms of annual production, output has been estimated to be about 150 tonne. However, this may not include any fish taken by the farmers.

Marketing

The marketing structure for fish harvested from Kumasi ponds appears to be very inefficient. Due to the fact that most fish farmers do not have the necessary (expensive) nets and transport, the Fisheries Department usually harvests for them once a year. Larger fish are caught by the Department and sold to the general public, restaurants, 'chop bars' and processors. The latter prepare salted fish (koobi). Prices are about 3,000 cedi per kg for catfish and 1,500 cedi for tilapia.

This system of marketing is not satisfactory and purchasers complain about the price of the fish, which compares unfavourably with those caught from the wild. There are also complaints about the size of the fish and their freshness. The small size of fish may in part be due to the failure of the Department to net the ponds at the optimum time, resulting in overpopulation and restricted growth.

Changes in production systems due to urban pressures

Cattle

Cattle-keepers in Kumasi City are under a variety of pressures, including:

- The local authority's attitude to animals in the city.
- Farmers' attitude to stall-feeding.
- High cost of production relative to that in other parts of Ghana and other countries.

The KMA authorities look with disfavour on cattle keeping and have attempted to move animals out of the centre of the city to the peri-urban zone. The farmers, who believe that moving to the outskirts would increase the risk of trypanosomiasis and increase production costs, have resisted this pressure (Akyeasi, 1999, p.30).

Table 4.9. Fish farming in and near Kumasi

Aspect	Narrative summary
Breeds	Species most frequently farmed are tilapia (mostly *Oreochromis niloticus)* and catfish *(mostly Heterobranchus* sp.*). Clarias* sp. and *Chrysichthys* sp.*, Chana obscura and Heterotis niloticus* are also cultivated.
Source of fingerlings	Most farmers obtain fingerlings from the Fisheries Department. Costs: 100-130 cedis for catfish and 50 cedis for tilapia. The Department brings the fingerlings to the ponds 11% of farmers obtain stock from the wild.
Stocking density and species combinations	Normal practice is 3-5 fingerlings per m^2. 90% of farmers stock with tilapia and *Heterobranchus sp.* in ratio of 10:1.
Nature of water body	Ponds constructed in valley bottoms, the majority having earth banks, which are poorly maintained. Sizes ranged from 12 m^2 to 54,000 m^2, depths mostly are in the range 1.5 to 2 m. Most ponds cannot be drained.
Feeding	All farmers practice feeding. maize bran, brewers' grains, groundnut husk and paste, leaves, coconut fibre are used. Most use groundnut husk and maize bran. Most feed twice daily.
Harvesting	Most farmers do not have nets for harvesting, or transport to markets, so usual practice is for the Fisheries Department to harvest once yearly.
Fertilising and liming	68% of farmers use poultry manure to increase the nutrient level of the water. Liming with slaked lime (to suppress disease) is not regularly carried out and only 18% followed this practice.
Extension	71% of farmers consult the Fisheries Department regularly. Advisory literature is available from the Department.

Source: Agyapong (1999).

The casual attitude to manure disposal must be one reason for the authorities dislike of the animals and it is possible that better use of the manure would lead to a change in attitude, as well as being cost-effective from a crop production standpoint.

With regard to stall feeding, so long as grazing is available within the city and is plentiful enough, a case can be made for keeping cattle in Kumasi. The extra costs in terms of time and labour of stall-feeding, together with the sensible

use of biomass produced within the city that might otherwise be wasted argue against any change to current practices. Survey results showed that only four or five farmers thought that intensification of production would be worthwhile (Akyeasi, 1999, p.30).

Additional pressures placed on the livestock keeper include the gradual loss of grazing to urban development, and for those wishing to embark on cattle keeping and/or increase the scale of operation, the costs involved in livestock purchase. They rank constraints in the order:

Credit: disease: feeding: housing in the ratios 52: 31: 17: 16.

Disease as a factor appears to rest on the high and rising cost of medication (Akyeasi, 1999b, p.29).

Pigs

In the past there has been considerable pressure on pig keepers to abandon free ranging production systems in favour of more intensive systems. Legislation was introduced that led to the housing of pigs and the use of animals more suited to these conditions, such as the Large White (Yorkshire in the USA), which has much better performance than the indigenous Ashanti (Anyinadu, 1999, p.46). No doubt this pressure arose from the damage that the roaming pig can cause to crops, the danger to road traffic, noise etc.

Notwithstanding, a measure of intolerance to pig husbandry in the city remains, centred on their smell and noise. Added to these annoyances is the danger that the effluent from some piggeries may find its way into water bodies and cause pollution (Anyinadu, 1999, p.45). The above pressures are directed against the 'city pig' but there is one major opposing pressure, the increasing demand for pork and pork products, which may prevail.

Poultry

The poultry industry in around Kumasi appears to be well accepted by the populace and poultry farmers are not subjected to adverse pressures of any kind arising from urbanisation. The main barriers to the expansion of the industry are the capital costs involved in setting up a unit (land acquisition, buildings, and equipment) and funding the first throughput (day-old-chicks, drugs, feed) (Kwakuyi, 1999, p.53).

Shoats

There are indications that the smells associated with shoats and their manure in the city are an irritation to neighbours of the farmers. The increasing demand for meat in Kumasi may cause the level of production to increase still further (Kwame, 1999, p.37).

In the peri-urban areas, theft of animals is mentioned as a problem, perpetrated by city dwellers, in the farmers' view (Holland *et al.*, 1996b, p. 30, 44, 76). Labour costs are rising due to competition from city employers offering alternative forms of employment [e.g. Holland *et al.* (1996b, p. 44)], land is increasingly scare, in some cases due to speculation, (Holland *et al.*, 1996b, p. 44, 93) and farm sizes are falling (ibid, p. 60).

Small animals

Small animal keepers are subject to much the same sorts of pressures as large-animal farmers, i.e. lack of land, complaints from neighbours about smells and decreasing availability of cheap feeds and credit. Several of these pressures are of course common to rural farmers (Solomon,1999, p.72).

Fish farming

Fish farming in Kumasi is a relatively new venture, having started in Ashanti in 1972. Its expansion to its present size is evidence of the demand in the city. Other than this there appear to be few <u>urban</u> pressures on the industry. However, there must be other pressures of a commercial or technical nature, as several ponds have been abandoned and several farmers have ceased raising fish (Agyapong, 1999, p.82).

Characteristic of stakeholders

Cattle

Most of the cattle owners interviewed in the city were Ghanaians and the major came from the north of the country; there were a few from Mali and a single European. In contrast, herdsmen hired by the owners were mostly from Mali. Most of the cattle are to be found in old, high density, low class residential areas of Aboabo and Mossi Zongo (Akyeasi, 1999).

Cattle owners do not appear to be particularly poor. The average capital value of stock was about 12.5 million cedis and it was reckoned by Akyeasi (1999) that a profit of around 0.5 million cedis could be made by fattening an animal over a period of 8-10 months. Further, the herdsmen seem to be better off than are those in other forms of manual labour.

Owners often had other sources of income, including office work, transport operations and skilled manual work, but the majority (60%) also trade in cattle as well as keep them. The position of cattle farming in the economy of the city is illustrated by the fact that over 80% of respondents kept the animals for profit and few for consumption or social reasons.

The formulation of new policies in this sector has to reconcile positive and negative aspects of urban agriculture. At present, the case for keeping them in the urban and peri-urban zones is underpinned by the efficient utilisation of forage on undeveloped land and waste vegetable material plus freedom from trypanosomiasis. Negative factors are increasing intolerance to the animals and the haphazard way in which their dung is disposed. As in Hubli-Dharwad, official policy is in favour of moving them out of the city to, at closest, the peri-urban zone. How this might be supported by an external agency is the problem that must be faced and answered.

Pigs

Survey results provide an excellent account of the characteristics of the pig farmers of Kumasi and Table 4.10 provides a brief summary. The most striking feature of this table is that only 25% of respondents are full-time farmers, others have an important secondary occupation, such as civil servant or artisan. While it is possible to make a living from pigs alone (15% had no other enterprise), the majority have an alternative way of making money. The scale of production noted above also clearly indicates that pig keeping is a part-time exercise in Kumasi (Anyinadu*, 1999, p.39).

Poultry

The characteristics of the farmers interviewed are summarised in Table 4.11.

There is no evidence that any of the larger poultry-unit owners were poor. As can be seen from Table 4.11 many had another professional occupation or trade while the balance derived their livelihoods from poultry farming. It seems

probable that the latter were in a larger way of business, but this should be confirmed. There is ample evidence of the profitability of poultry keeping (Kwakuyi, 1999, p.51) when the units are close to markets. However, some producers in the peri-urban area complain about the cost of transport of eggs to the city (Holland *et al*., 1996b, p. 29, 92).

Table 4.10 Characteristics of Kumasi pig farmers

Aspect	Narrative summary
Ethnic origin	20% from North Ghana; remainder are Akans (Ashanti, Fanti, Kwahu), Frafra or Grushie, i.e. non-Muslims.
Occupation	15% have no occupation other than pig keeping, 25% farm other crops or animals, and 60% have an important second occupation.
Age distribution	About 33% aged <20 – 30; 30% aged 31-50 and 33% over 50.
Sex and Marital status.	92% males. 75% married, 10% single, the balance divorcees or widowers.
Educational background	2.5% illiterate, 10% primary school, 57.5% middle school and 30% secondary/higher education.
Number of children	35% have no children, average family size of those with children = 4.

Source: Anyinadu (1999)

Shoats

Table 4.12. summarises the sheep and goat farmers' characteristics for the urban area.

In the peri-urban area it seems that there may be large flocks, owned by newcomers to the industry. The number and significance of such flocks is not clear but they were found in two of the six villages where PRA was carried out [Blake *et al* (1997, p.51, 55); Holland *et al.* (1996a, p.46)]. Such flocks, however, appear to be better managed.

Table 4.11 Characteristics of Kumasi large–scale poultry keepers

Aspect	Narrative summary
Ethnic origin	80% Ashanti; 20% Fanti or from N. Ghana.
Sex	Mostly owned by men (Blake *et al.* (1997a, p.46).
Occupations	40% exclusively poultry farmers, 55% had another profession and 5% another trade.
Age	Most aged 41-60 years.
Educational background	Middle school: 17.5% To O and A-level: 45% Graduates/professional training: 37.5%
Marital status/children	All married, family size 3-13 children (mode of 6)
Caretakers (i.e. those caring for the birds)	All farms employed caretakers. Most are men but two wives care for the birds. Most caretakers are educated, some to graduate level.
Training and advice	It is not clear whether or not the farmers had had formal training in poultry husbandry, but most believed that this to be highly desirable. All farmers took professional advice from government, university or private sources on aspects of husbandry

Source: Kwakuyi (1999)

Table 4.12 Characteristics of Kumasi sheep and goat keepers

Aspect	Narrative summary
Ethnic background	56% from N. Ghana, 30% Akan, 14% others
Age	84% aged 30-60 years
Shepherds/goatherds	72% are the children of owners, 18% owners themselves, 10% relatives of owners.
Reasons for keeping animals	66% for cash income and the balance for cash and home consumption. Some owners (24%) keep the animals for secondary reasons, e.g. as a matter of pride or as an offertory (14%).

Source: Kwame (1999)

Small animals

Key features are summarised in Table 4.13.

Table 4.13. Characteristics of small-animal keepers in Kumasi

Aspect	Narrative summary
Sex	All respondents keeping animals were males.
Standard of Living	Not clear, see above.
Ethnical affiliation	Ga, Frafra, Dagati, Ewe, Fanti and Ashantis were all represented. Akrans are the only people to keep snails.
Other occupations	Various, ranging from schoolchildren to civil servants. All appear to have been part timers.

Source: Solomon (1999)

Fish farmers

Table 4.14 summarises key features of the fish-farming community.

Table 4.14. Characteristics of fish farmers in Kumasi

Aspect	Narrative summary
Sex	92% of farmers were males.
Education	About 70% of farmers had received secondary or tertiary education.
Ownership of ponds	All ponds were owner by farmers or, in one case, by a company
Ownership of land	About 70% owner the land where the pond was located, the rest leased the land.
Record keeping	All farmers are poor record keepers, which makes accurate estimates of their annual crop difficult to estimate and handicaps their management of the ponds.

Source: Agyepong (1999)

Livelihood strategies of poor households

The situation is similar for peri-urban Hubli-Dharwad. There is a little information on husbandry methods, but again the association between livestock ownership, wealth and other money-earning activities has not been established.

The effects upon the poor of changes to the PUI land use driven by urban development, strategy options and interventions

Access to land and security of tenure in the villages around Kumasi are problems, but some farmers appear to be resigned to these [e.g. Holland *et al.* (1996b, p.30)]. Another problem of an urban nature is theft. Access to credit, poor extension support and veterinary services, and, for pigs and poultry the cost of feeding stuffs and transport charges are more general in character.

Solving the general problems in a sustainable way clearly requires the strengthening of links between the farmers and the governmental services supplying credit, extension and veterinary support.

5 Land, water and waste management

Characterisation of production systems

Kumasi

Introduction

The Kumasi Baseline Study (Holland *et al.*, 1996a) provides a very useful and detailed overview of most of the relevant environmental as well as soil and water management issues.

The Inception Report for "Kumasi Natural Resource Management Project at the Watershed level" (R7330) also provides the some basic descriptions of the environmental features of the area around Kumasi: rainfall, soils, terrain (CEDAR, 1999, p.10). Kumasi Metropolitan Assembly (KMA) contains 77 villages (Nsiah-Gyabaah, 2000). A description of land use and farming systems is given (available in more detail in another document[1]). A useful list of data sources on the environmental around Kumasi is given. Access to primary data sources does not appear to be a constraint though there is a lack of understanding of processes in some areas – for example the interactions between source of pollution and pollution in the watercourses.

The Inception Report for R7330 contains a qualitative assessment of the farming systems and degree of urbanisation in the sample villages (CEDAR, 1999, p.42). It also provides a qualitative evaluation of environmental concerns and benefits of the various production systems around Kumasi, including how these relate to soil and water management (*e.g.* crops that help to protect the soil, pollution from fertilisers and agro-chemicals, use of contaminated water for cooking and processing, etc., manure production from livestock, etc., and contamination from processing industries such as oil palm and sugar). Contamination from agriculture is assessed.

Information is given for the sample of villages on population and demography; facilities (infrastructure, etc.); occupations; waste management and sanitation (considered to be generally inadequate).

Climate

The mean annual rainfall for Kumasi is 1345 mm (Holland *et al.*, 1996a, p.13)[2]. The distribution is weakly bimodal with a major peak (usually) in June (peak varies from April to July) and a minor peak in September (varies from August to October). Data (11 years) are inadequate to analyse for long term trends. Mean monthly temperatures vary from 24°C to 28°C with minima and maxima ranging from 20°C to 33°C. Humidity varies from about 50% in the dry season to about 76% at the end of the main wet season. Tables are presented in Holland *et al*. (1996a) (Appendix IV).

Topography

Kumasi itself is about 282 m (Nsiah-Gyabaah, 2000) but altitudes in the PUI around Kumasi vary from 250 to 300 m (Holland *et al*., 1996a, p.13). The landscape is much dissected though the variations in height are rarely more than 50 m. Slopes are rarely over 7.5%. The climate is classified as semi-humid tropical.

Soil resources

The baseline study (Holland *et al*., 1996a, p.13-14) explains that the soils belong to the Forest Ochrosol great group. Though formerly high in organic matter, intensive agriculture has led to many areas now being low in OM. References to detailed studies are given. The following points are made:

- Macro-nutrients are very low and micro-nutrients are deficient in some areas.
- Clay minerals are predominantly kaolin so CEC is very low.
- Before intensive (over-) cultivation erosion, soil physical properties are favourable to crop growth but erosion is severe in some areas and physical properties are now poor.
- Structure becomes weak when OM is reduced.
- Seasonal waterlogging occurs in many valley bottoms the soils becoming hard and structureless when dry (some areas are used for rice cultivation).
- Erosion of topsoil can have a large effect on soil fertility;
- Regeneration of fallow cover is rapid in soils which are not too degraded.

The soils in six sample villages around Kumasi were surveyed and samples analysed (CEDAR, 1999), but no map of the soils in the villages have been seen. The soils are developed on granite or phyllites. The soils on the granites are quite acidic but those on the phyllites are less acidic. The dominant textures are sandy loams. Soil classes are: Ferric Acrisols (most common), Haplic Acrisols, Eutric Gleysols, Gleyic Arenosols and Gleyic Cambisols (FAO-UNESCO).

Nitrogen and organic matter content tend to be moderate to high, at least when they are newly cultivated after fallow. However the soils are often seriously deficient in phosphorous and potassium.

The farmers classify soils primarily on colour and position in the landscape. Different cropping capabilities for different soil types are recognised by the farmers. These are included together with a summary of the main properties of the soil series in the sample villages in Table 5.1. (CEDAR, 1999).

Land use and farm sizes

There seems to be little information on the relationship between land use and farm sizes around Kumasi though at the final workshop for the Natural Resource Management Project (R6799), Nsiah-Gyabaah (2000) noted that 90% of farms are less than 2 ha. It does appear there is increasing insecurity with regards to land tenure.

Research priorities include:

- Investigating ways of improving land security.
- Valuation of land for planning purposes (more use / adapting evaluation of existing land classification scheme and making larger scale maps and making maps more available).
- Investigate changes in the control and disposal of land.
- Completing the collection of necessary information on natural resource systems.

Use of soil ameliorants by farmers

It was noted that low amounts of fertiliser were used around Kumasi but that leaching was still taking place, partly due to timing of applications not being synchronised with plant demand, and partly due to "hot spots" where relatively high levels of fertilisers were being used such as intensive tomato production areas (CEDAR, 1999, p. 43). The use of compost also is not very widespread (see under Possible Strategies, later in this chapter).

Technical interventions to improve soil fertility are known though may need adapting. However, it is more important to develop agricultural systems from local to regional level which will ensure sustainable production. Research to identify the scope for improvements in land management processes in the traditional and state systems needs to be undertaken.

Water resources and utilisation

According to the Baseline Study (Holland *et al.*, 1996a, p.15), three-quarters of the PUI around Kumasi are drained by the R. Sisa and the R. Oda. The remainder drains by a system of smaller streams into the Owabi reservoir. References to studies providing detailed flow data are given.

About 100×10^3 m^3 of water are required for domestic purposes in Kumasi itself (Holland *et al.*, 1996a, p.60). Three quarters of this can be delivered from the current sources, Owabi and Borakese reservoirs. Use of Lake Bosomtwi, 28 km from Kumasi has been suggested.

CEDAR (1999, p.14 ff.) states that to characterise the water resources in an area, it is necessary to define the sources of supply; the quality of water at the sources; the range of uses of the water; the types and scale of abstraction; and the contamination of the sources, sinks, and pathways. Some preliminary findings on the eight study villages are presented (ibid, p.38 ff.) on water resources. However, in general little information is actually provided. The document notes that:

- The rainfall is sufficient for the maintenance of an integrated (flowing) stream network for most of the year.
- There is generally reduced flow in the dry season (low order streams may dry up).
- There is a plentiful supply of groundwater.
- Springs constitute a significant source of water in the catchments.

In a discussion with farmers who attended the Final Workshop (Brook, 2000, p.16) it was reported that they said that:

- Dry season supply is a problem (quality and quantity).
- Some farmers dig shallow (c. 1 m deep) ponds.
- Sometimes waterlogging is a problem during the rainy season.
- The farmers think that the government should construct more boreholes.
- The farmers believed that district assemblies should prohibit cultivation along rivers to prevent contamination of the water supply.

The delivery is unreliable at the end of the pipe system. In fact, very few of the PUI farmers benefit from piped water. There is a need to find ways of improving supplies for drinking, livestock watering and, irrigation.

Intensive horticulture in the valley bottoms is being carried out and in some cases, where available, piped water is used. Piped water must be paid for so very

little is used for irrigation. Most water for irrigation is obtained from shallow wells and used for:

- Sole crop vegetable growing.
- Specialised valley bottom cropping systems (rice, water coco-yam, sugar cane).
- Trees (establishment or dry season irrigation).
- Backyard farms (water from wells, roofs, piped supplies).

The Community Water and Sanitation Agency exists for the area outside the area served by the Ghana Water Company (GWC). It is an enabling organisation to facilitate aid programmes but has no resources of its own. Consequently, boreholes and wells in the area are constructed either privately or by aid agencies. It appears there is little if any control of siting.

Researchable themes concerned with water supply and management include:

- Water conservation, storage and management for domestic use.
- Address overlapping management issues relating to GWC and village levels.
- Valuation of water used in agriculture.
- Develop/ adapt small scale supplementary ("insuranc   -saving") irrigation technologies.

There are conflicting views about the potential for boreholes (Holland *et al.*, 1996a, p.61) and more research into both surface and groundwater resources is needed. Simple technologies to capture and store water at farm and village level are available but these need adapting and villagers need encouragement to adopt them.

Water quality

Pollution is a problem because controls on discharge are difficult to enforce. The rivers are used for washing (people, clothes and vehicles), and people drink from contaminated streams in times of shortage in more rural areas (CEDAR, 1999).

Potential water quality problems around Kumasi identified included:

- River pollution in and downstream from Kumasi (it is in the upper part of a catchment) from:
  - Untreated sewage and other domestic waste;
  - Hospital waste;
  - Industrial waste (chemicals, heavy metals, oils, sawmill waste, brewing waste, abattoir waste);
  - Urban and rural runoff (including agricultural chemicals and residues);
  - Leachate from groundwater entering the rivers;
- Contamination of boreholes and wells from the polluted rivers and pit latrines located nearby and/or upslope.
- Waste tipping (unplanned and unregulated) and inadequate management / mitigation procedures.
- Localised heavy resource with:
  - Sand winning (quarrying) for building;
  - Trees for fuel and wood;
  - Building operations for urban and peri-urban housing and industrial / commercial premises.

It is not clear how these issues were identified.

Some preliminary findings about water quality on the eight study villages are presented (CEDAR, 1999, p.38 ff.)[3].

Water quality measurements indicate:

- There is a relatively high sediment load in the more urbanised areas and downstream of Kumasi.
- The electrical conductivity and compounds of nitrogen are higher in these areas though are low in absolute terms.
- The nutrient status of the water is generally low.
- That overall quality meets WHO and EU standards except for turbidity and true colour.

Additional monitoring is required before a clearer understanding is achieved.

Particular sources of pollution of surface water are both small and large scale industries (vehicle repairs, breweries, abattoir, tannery, sawmills); semi-liquid human waste and agricultural chemicals. Of particular concern is the Owabi nature reserve which is suffering from pollution as well as encroachment (Holland   *et   al.*,   1996a).

Table 5.1 Soil characteristics in relation to topography around Kumasi

Topo-graphy	Summit and upper			Middle slopes		Lower slopes		Valley bottom	
Soil series	Kumasi	Asuansi	Bekwai	Nzima	Akroso	Nta	Kokofu	Oda	Densu[3]
Parent rock	Granite		Phyllite		Granite		Phyllite		Granite
Local name	Asase korkor (red soil)			Asase tuntum (black soil)		Afonwea (sandy soil)		Aworaho (soils near streams)	
Capa-bility	Fertile. Almost all crops. Cocoa & citrus			Arable and vegetable crops. Also tree crops.		Tuber crops such as cassava. Vegetables & oil palm		Sugar cane, taro, paddy rice, dry season vegetables	
PH[4]	4.3/4.2 (very acidic)	4.5 to 6.8 (v.acidic to)	5.5 to 5.9 (mod. Acidic)	5.7 (moderat e)	5.7 to 6.0 (slight-moderate)	4.9 to 6.2 (slightl)	4.8 to 6.1 (very to slightly)	5.4 to 6.4 (slightl)	4.7 to 5.0 (very to)
Organic matter	3%/1.5% (moderat e)	2.8 to 5.2% (mod. To)	3.5 to 6.6 (high to v.high)	6.6/3.0 v.high/hi gh	1.6 to 3.5% (mod. To)	0.9 to 2% (mod.)	1.7 to 2.4% (moderat)	2.6 – 4.4/ 0.8 - 1	1.8/0.8 (mod./ v.low)
Nitrogen (%)	0.22/0.1 5 (moderat	0.22 to 0.27% high/mod	0.13 to 0.38% (mod.to	0.38/0.1 7 (high/mo	0.13 to 0.25% moderate	0.13 to 0.25% modera	0.15 to 0.22 moderate	0.18 to 0.24 high	0.24/ 0.04 (high/lo
Phospho-rous (Bray) [ppm]	1.25/0.5 (v. low)	1.2 to 3.7 (v. low)	0.8 to 2.2 ppm (v. low)	"deficient "	1.15 to 3.75 (very low)	1.6 to 19 (v. low to)	1.6 to 4 ppm (very low)	3.5 to 28 very low to	0.6 / 0.6 (very low)
Potassium [ppm]	43.5 / 26.5 (deficient)	58 to 136 (mod to high) /	45 to 95 (moderate) / (low to v.	71/36 (moderat e)	86 to 145 ppm (mod. to)	33 to 168 (v. low)	48 to 165 ppm (low to	100 to 105 / 68 to 2.. (high)	51 to 115 (high)
Exchan-geable bases	low	Low to mod. (K is v.	Moderate	mod. but K is low	moderate to low	low to modera te	(low to mod.) / v. low (K	moder ate	low (but K is moderate
Cation Exchange Capacity	low	Low to mod.	low to (mostly) moderate	mod.	Low	very low	low	low to (mostl y) moder	low / low
Dominant textures	sandy clay / clay	sandy loam / sandy	loam / clay loam	loam / gravelly loam	coarse gravelly loam /	loamy sand / sandy	loam / sandy loam	sandy loam / sandy	sandy loam / loamy
Slopes	4%	2 to 10%	2%	10%	4 to 5%	0 to 4%	2 to 10%	1%	0.5 to 1%
Classifi-cation System	Ferric Acrisols			Haplic Acrisol		Gleyic Arenos ol	Haplic Acrisol / Gleyic Cambisol	Eutric Gleysol	

Future research should emphasise pollution prevention and management. Researchable constraints include (Holland *et al*., 1996a, p.64):

- Agrochemicals (extent and impact on ecology / produce / human health).
- Ways of improving farmers, management of agrochemicals.
- Reduce sewage and industrial pollution (technical and policy solutions needed).
- Impact of fuelwood collection and charcoal production on erosion and water resources.
- Develop community based management system for Owabi reserve.

Aquaculture

In 1995, there were 123 fish farms around Kumasi though not all have survived because of lack of technical advice (Holland *et al*., 1996a, p.51). An interesting integrated system developed locally has been to combine vegetable production on raised beds with fish production in pools between the beds. Risks from flooding are high as are the potential for poisoning from pesticides. More research is needed on the effect of agricultural chemicals on aquaculture. For further details, see Chapter 4.

Hubli Dharwad

Introduction

There seems to be relatively little information on soil and water management *per se* other than compost and waste utilisation. In particular there is a lack of information about agricultural tools and equipment used, soil erosion problems, irrigation methods and management. There is no evidence of soil maps being used in the planning process. Analyses of rainfall are rather basic, although more detailed than for Kumasi.

The main contribution to the characterisation of the production systems around Hubli-Dharwad was through R6825, the "Baseline Study and Introductory Workshop" project (University of Birmingham *et al*., 1998a, 1998b). The key themes of the study were the documentation of socio-economic characteristics, changes in land use and farming systems, renewable energy, water resources, and government planning.

To put the Hubli-Dharwad PUI into context, the Baseline Study (ibid) also describes the farming systems and climate in Karnataka state and Dharwad district.

The production systems for the two peri-urban case study villages were also characterised as part of the preparation for R7099, the "Urban Waste Utilisation Project in the Hubli-Dharwad City-Region" project (University of Birmingham *et al*., 1998c). In particular, data were collected on:

- Composts that farmers are presently using and why.
- What crops are they growing.
- What are the environmental conditions in which the agriculture is taking place.
- Where the crops are being marketed.

Table 5.2 (University of Birmingham *et al*., 1999a) summarises the environment and cropping systems of 10 farmers in the two villages participating in the trials to evaluate various forms of composted waste and illustrates the range of conditions around Hubli-Dharwad. There was no formal wealth ranking of the farmers to decide which would participate in the trials though there was an attempt to use the poorer farmers in each village. However Navalur is much nearer to Dharwad, has black (more fertile) soil and the farm sizes of the Navalur sample are much larger and so the farmers in Navalur are clearly much better off than those in Mugad. The lack of information about the wealth status of farmers has been referred to in other chapters of this book.

The labour economy of different cropping systems has also been summarised (Nunan, 2000). However, there is only a little information about the labour costs and constraints associated with the preparation and application of the various processed forms of USW (Nunan, 1999a: p. 73).

Climate

Rainfall seems to be increasing in Hubli-Dharwad by about 0.5% to 0.6% per year (contrary to what farmers claim). There is no evidence of increasing variability at a monthly resolution. However, the monsoons may be starting and ending slightly later, by a week or two. University of Birmingham *et al* (1998d) gives more detailed information on monthly mean rainfall, minimum and maximum   temperatures   and   relative   humidity..

Table 5.2. Comparison of environmental and cropping systems in two villages

	Mugad village	Navalur village
Climate		
Rainfall (mm / year)	950	800
Soils		
Dominant soil	red	black
pH	mostly acidic (<6.5)	mostly alkaline (> 7.5)
Organic matter	mostly low (0.5%) to medium (0.5 to 0.75%)	mostly low (0.5%)
Available nitrogen	low (<280 ppm) to medium (280 - 560 ppm)	low (<280 ppm)
Potassium	high (> 280 ppm)	high (> 280 ppm)
Land		
Mean farm size	1.9	3.0
Range of farm sizes (ha)	0.8 to 3.6	1.6 to 5.7
No. in sample	5	5
Average area leased (ha)	Nil	3.9
Range of leased land (ha)	-	1.6 to 6.5
Crops and their management		
Main *kharif* (monsoon season) crop	rice	potatoes (also greengram, maize, groundnut, cotton)
Percentage of sample farmers growing rabi crop	80%	100%
Main *rabi* (post-monsoon) crop	grams (grain pulses - mainly mung bean)	sorghum, chickpeas, wheat, safflower
Preferred soil ameliorant	pit compost	pit compost
Frequency applied	1 in 2 or 3 years	1 in 2 or 3 years
Percentage applying in year of study	60%	100%
USW use	None	1/5 this year; 3/5 in recent years
Use of inorganics	DAP at sowing, urea as top dressing	DAP at sowing, urea as top dressing
Proportion applying in year of survey	2/5	all
Use of insecticides and fungicides	nil	all

Soils

Soils are mostly vertisols or alfisols (University of Birmingham *et al.*, 1998a). Their properties are briefly described in the document in perhaps a rather over-simplified form. More detailed information is apparently available but was not presented. Little use seems to be made of soil maps or land classification maps in planning.

The initial workshop [July, 1997] for the "Baseline Study Project for Hubli-Dharwad City Region" (R6825) identified the need to find ways of improving soil fertility.

Land use and farm sizes

Information on present land use and changes in land use is generally better in Hubli-Dharwad than Kumasi. During the baseline study (University of Birmingham *et al.*, 1998b, p.178), 21 villages were sampled for a study of land pressure. It was found that 33% of the villages had average farm areas of less than 2 ha per household. One village had less than 1 ha per household. There seems to be no simple relationship between farm size and proximity to Hubli-Dharwad. Small landowners constitute 26 to 72% and large landowners constitute 4 to 37% of the total farmers; most of the latter practising dryland farming on the vertisols to the east, where farms tend to be larger.

The report also presented data collated from the 1981 and 1991 censuses, covering 372 villages across five taluka (sub-district administrative unit). The proportion of land under irrigation varies widely from 0.3% to 19% again indicating a large variation in wealth distribution both within and between villages. Pilot projects could examine the potential for increasing the area under irrigation in those taluka with least resources (Kundgol, Hubli, Dharwad).

Cultivable waste land occupies only 3% of the peri-urban area though there were 19 villages (of 372) where the proportion was over 25%. Land available for cultivation in 1991 was about 4% of the PU area, a decline of 34% since 1981 (University of Birmingham *et al.*, 1998b, p.196).

Forest land (University of Birmingham *et al.*, 1998a, p.182 ff.) occupied 0% to over 50% of land in the peri-urban area though between 60 and 100% of villages had no forests (and had none in 1981). No information is presented on forest ownership, yield, species, utilisation, management, density (for example the proportion of forest land with no trees). In only 12% of villages did forests

occupy over 25% of the land. Even so, encroachment was rarely a problem (ibid, p. 183-184). Forests are a significant form of land uses only in more hilly, wetter areas south and west of Hubli-Dharwad.

Use of soil ameliorants by farmers

A survey of farmers in connection with the "Urban Waste Utilisation in the Hubli-Dharwad City-Region" project (R7099) revealed that all farmers understood the need for and applied soil fertility amendments (University of Birmingham *et al*., 1998a, 1999a, 1999b, 2000). Their preferred amendment is pit compost (manure and crop residue) applied before the rains and ploughed in after the rains have softened the soil (because compost improved water holding capacity and soil structure, so ploughing is easier). Farmers thought the residual fertility from compost would last up to three years. They were aware that compost improved soil structure, resulting in lower draught requirement. However it was revealed that composts are in short supply. Thus di-ammonium phosphate (DAP) and urea was often used, sometimes alone but often to supplement the compost, more as an unavoidable necessity because of the shortage of organic manure rather than because they preferred inorganic fertilizer. Cost was another factor limiting the use of inorganic fertilizer at the recommended (Department of Agriculture) rates. Farmers also thought that inorganic fertilisers require adequate rainfall to be effective and that the residual effects of inorganic fertilisers were short-lived (commonly thought to be about one year). Inorganic fertilisers were considered to affect soil structure adversely.

Some farmers use green manures (often neem or *Gliricidia* spp.) composted with grass and soil for one month (a recent Dept. of Agriculture recommendation). However their use does not seem to be generally widespread.

A typical application rate for compost is 10 t ha^{-1} y^{-1}. Cost comparisons for various forms of compost are presented in Table 5.3.

Pit compost thus had the advantage of having the same cost per unit of nitrogen content as DAP but having the added value of improving soil structure and water holding capacity. Any USW based product would have to have a similar price. Vermicompost is clearly not accessible to resource poor farmers because of cost. Those farmers who currently buy USW separate compostable material themselves, so decreasing purchase cost but increasing labour or opportunity costs.

Table 5.3. Cost comparisons per kg N between various forms of soil amendment used around Hubli-Dharwad.

Type of manure / compost	Cost per unit weight	Cost per kg of N
DAP (17 % N)	Rs 420 / 50 kg bag	Rs 19
Urea (46% N)	Rs 420 / 50 kg bag (estimated)	Rs 7
Pit compost (1% N)	Rs 175 to Rs 200 t^{-1} (mainly opportunity cost)	Rs 17.5 to Rs 20
Vermicompost (1% N)	Rs 2 kg^{-1} to Rs 4 kg^{-1}	Rs 200 to Rs 400

Source: Nunan (1999a) p. 28.

Water resources

Data are only available for Dharwad District (ibid, p. 104), and available resources are:

- 390 small reservoirs (tanks) sufficient for 55,575 ha.
- 31 lift irrigation schemes sufficient for 12,004 ha.
- 15 barrages sufficient for 4,098 ha.
- 434 minor irrigation schemes sufficient for 71,678 ha.
- Boreholes (number not known) are used mainly for domestic purposes.
  It is not clear how much of these resources are being used for irrigation.

Water tax is collected by the head of each taluka on behalf of the Revenue Department. An Irrigation Committee is frequently appointed but the secretary is always a civil servant engineer. There is little information on how effectively these committees operate.

Common problems experienced are: timeliness of availability (often late); lack of structural maintenance (it is unclear at present whose responsibility this is, and farmers may think that it is the government's job); equitability of distribution and salinisation through excessive applications. No details are given of these problems and there is an information gap here. The introduction of Participatory Irrigation Management and Water Users Associations should be encouraged, as exist elsewhere in India. No details of such organisations in Hubli-Dharwad are given.

An evaluation of threats to water resources by urban development was undertaken by the "Natural Resources Valuation" project, R7269 (Nunan, 2000).

The survey concentrated on the impact of urbanisation of Unkal Tank between Hubli and Dharwad, which until 1996 was a major source of domestic water for Hubli-Dharwad. In 1996, the pollution of the tank had become so great as a result of under-regulated housing development that extraction for domestic water supply for Hubli-Dharwad was no longer possible and the extra water had to be obtained from Malaprabha Dam and Neeragager Tank, both some distance from Hubli-Dharwad and outside the municipality.

In this event, there were winners and losers. The main loser is the Karnataka Urban Water Supply and Drainage Board who now supply Hubli-Dharwad with the additional domestic water needed but who receive no additional payments. Malaprabha Dam is also a source of irrigation, so the loss of some of the water to replace the polluted domestic water in Hubli-Dharwad has presumably had an impact on these farmers. The amount of water actually extracted from Malaprabha Dam is not given but the total provided by Malaprabha Dam and Neeragager Tank is 2.3 x 10^6 m^3.

Unkal Tank is now used primarily for leisure activities, washing (vehicles and clothes). However private and commercial fishing (in roughly equal proportions) now takes place with an annual value of Rs 830,000[4]. The changes have made little difference to the previously illicit irrigation around the edge of the tank. The costs of any increased ill-health and damage to the economy are unknown.

Researchable issues on water resources and irrigation (University of Birmingham *et al*., 1998a, p. 105) include:

- Quality and reliability of drinking water supplies.
- Functioning of institutions providing water (identify ways for better co-ordination between domestic, industrial, agricultural supplies).
- Physical and economic constraints to increasing irrigation supplies.
- Sources of pollution and ways of preventing it.
- Groundwater supplies (quality, quantity, use, pollution, management).
- Tank construction and management (siting, use, trends).

The initial "Urban Waste Utilisation Project in the Hubli-Dharwad City-Region" project R7099 workshop (University of Birmingham *et al,* 1998a) suggested that it was necessary to address problems related to use of wastewater from urban centres particularly the control of weeds and pests in waste water

systems. It also called for research on ways of improving moisture conservation, including use of waste water.

Trends and changes in land and water management due to urban growth

Kumasi

Introduction

Various projects have noted changes in land use patterns falling under the following headings.

Reduced duration of fallows and declining soil fertility

The length of fallows have been decreasing and in many instances, fallowing of land is now impossible because of land pressures (Holland *et al.,* 1996a, p.70; 1996b, p.30). However, bush fallow continues to be practised by some farmers even though fallows are now too short to maintain soil fertility (Holland *et al*., 1996a, p. 64; Blake *et al.,* 1997a). Soil fertility is therefore declining rapidly[5] (Holland *et al.,* 1996a, p.70). There is an increasing tendency to adopt short term management strategies with fewer tree crops and increased "mining" of soil nutrients. Declining fallow lengths and reduced soil fertility are identified as major production constraints by farmers (Kasanga, 1998, p.69). Management of soil fertility is declining.

Fewer people in farming

The Inception Report for "KNRM at the Watershed Level Project" (R7330) notes that fewer people are now involved in agriculture in the peri-urban environment (CEDAR, 1999, p.12). Small farm areas from which it is difficult to make a living, insecurity of tenure and increased potential for urban employment have presumably all contributed to this change. This is partly due to population and thus land pressures. Many of the people remaining in agriculture are the poor who are unable to capitalise on the proximity to markets to intensify their operations. There is not enough known about the process and reasons for the abandonment of land by farmers though the principal reason seems to be the changes   in   land   tenure.

Decreased security of access to land

It is considered that the apparent changes in security of access to land (see Chapter 6) is a significant factor in declining land husbandry practices. The greater feeling of insecurity is party due to the increasing practice of chiefs in selling off village land, thus denying farmers their traditional land rights (Adam, 2000b; Brook, 2000, pp.3-7). This is leading to increasing landlessness and homelessness. Women are possibly even more affected by the loss of their land than men.

In villages around Kumasi the land allocated for residential areas has increased rapidly, and the farmland has reduced (Blake *et al.,* 1997a). In Akokoabong, a village close to Kumasi, over 50% is allocated for housing and about 30% is left for farmland (Holland *et al.,* 1996b, p.19). Hardly any agricultural land remains for bush fallow (ibid, p.25) and intensive sharecropping is common. At the end of the four year term the land is rented out again immediately with no fallow, which is said to be decreasing fertility (ibid, p.19). Change since 1983 was noted: reduction in the amount of farmland and increase in the amount of residential land. Eleven percent of villages said there was virtually no farmland left in the villages (Blake *et al.,* 1997a, Holland *et al.,* 1996b, p.35). New land developments in villages tend to be single villa-type houses surrounded by yards. This consumes land less efficiently than traditional housing in the villages, but it offers opportunities for some small-scale backyard farming (Blake *et al.,* 1997a). The problem is exacerbated by new building outside the city which is not adequately planned. Unauthorised building by the middle classes on community institutions (such as schools) and on land belonging to the "rural poor" is reported (Holland *et al*., 1996a).

Slow development of agricultural entrepreneurs

For a relatively few farmers, the improved opportunities for marketing has led to higher value enterprises such as horticulture and poultry units although Nsiah-Gyabaah (2000) was of the opinion that the main change was from large scale plantations to food crop production for home consumption.

Hubli-Dharwad

Introduction

Changes in the land economy are described for Hubli-Dharwad in University of Birmingham *et al*. (1998a, 1998b).

Land pressures

Researchers have suggested there is a possible link between changes in land use and socio-economic indicators, and that socio-economic data collected in 1997 indicate increasing pressure upon land. This conclusion seems to rely upon increasing land values between 1987 and 1997 (University of Birmingham, *et al.,* 1998a, p.42), yet the values have not been adjusted for inflation, so this argument may not hold. Variations are high and complex. Information was not obtained on the number of sales taking place (ibid, p.33).

There has not been remarkable population growth in Hubli-Dharwad during the period 1981 to 1991, only 23% (University of Birmingham *et al.,* 1998a, p.14), and the increasing land pressures in the PUI not related in a simple way to distance from the urban areas. The pattern of growth and change is dynamic and complex to the west and north of the city, but rather stagnant and more agrarian elsewhere. Varying degrees of land pressure may be one of the factors, plus new opportunities for irrigation and changing cropping patterns and new opportunities for working in the city (University of Birmingham *et al.,* 1998a, iii, p.19). But some of the growth in population and economic activity in the rapidly changing taluka of Dharwad and Kalghatgi could possibly be explained by greater land availability, rather than proximity to the city (University of Birmingham *et al.,* 1998a, p.20). In Kundgol taluk there seems to have been an increase in the land available per cultivator. An important factor to keep in mind is that the growth of Hubli-Dharwad may not be a strong force for change. It is rather difficult to draw definite conclusions due to the number of gaps in information, for example, there is no information on the amount of land that is converted to urban use for Hubli-Dharwad.

Changes in land use

Over the interval between the 1981 and 1991 censuses, unirrigated cultivated land varies from 51 to 90% of taluka, the average in the PU area being 75% (University of Birmingham *et al*., 1998b). There was an average decrease of 0.2% p.a. in unirrigated cultivated land (varying from 0.03 to 0.3% p.a.). However, 40% of villages experienced an increase as opposed to 51% experiencing a decrease. In three of the five taluka, there has been an increase in the culturable waste areas by 100% to 650% over the decade, 1981 to 1991, but it is not clear what process is contributing to this.

There may be abandonment of farmland close to the city (University of Birmingham *et al.,* 1998a, p.22); however, this seems to conflict with the notion of general increase in pressure on land. Land not available for cultivation in 1991 was about 4% of the PU area, a decline of 34% since 1981 (ibid, p.196). Land used for urban purposes is included in this category along with water bodies and quarries (ibid, p.22). This is difficult to explain; possibly land previously considered too poor for cultivation has now been brought under production. Clearly there are complicated and still poorly understood dynamics at work. It is not certain whether urban pressures are the driving force behind observed changes.

The area irrigated remains relatively small, but has increased by 32% overall, but again variability is high, Kundgol taluk experiencing a decline. Dharwad taluk has the largest number of villages with increases in irrigated land over the decade and the largest increases in area irrigated, but irrigation is only extensive in Navalgund taluk. Nevertheless, many villages in the city-region showed a decline in irrigated area which may be linked to the increase in land available per cultivator (University of Birmingham *et al.,* 1998a, p.21).

Forests are significant users of land only in the hillier wetter areas south and west of Hubli-Dharwad. Forest encroachment is reported to not be a major problem (University of Birmingham *et al.,* 1998a, p.21). Rather surprisingly, forest area on average increased over the decade by 2.7% but the variation is high, some areas experiencing a decline in forest cover. There is no indication of the number of trees, the species or the beneficiaries of the new forest land.

Overall, the picture is complex and changes in land use and factors driving change seem to be poorly understood.

Change in occupations and village populations

To summarise (University of Birmingham *et al.*, 1998b), over the period between the 1981 and 1991 censuses:

- Whilst the number of labourers has increased by about 30%, the number of agricultural labourers has increased by only 16% and so agricultural labourers as a percentage of the total has declined.
- The number of non-agricultural artisans living in villages has increased by 42% over 1987 to 1997.
- Some village populations have increased while others have decreased, changes depending on land pressure, changes in agricultural practices,

employment opportunities and possibilities for commuting.

All villages experienced a decline in the average land per household (ibid, p.178). In contrast, in 24% of the villages, land per cultivator increased over the same period (even though land for the corresponding households had decreased). This indicates a decrease (on average) in the number of people in the households in those villages who are engaged in agriculture. Again there is no simple relationship between proximity to the city and the decline in the number of agriculturalists.

The farm area per person is declining between 1.3 and 2.9% p.a. whilst the farm area per household is declining faster at 2.0 to 3.3% p.a. Median values for average area per household in a village varies from 3 ha to 4.5 ha. However the proportion of villages with (an average of) of over 5 ha varies from 12% to 40% indicating a wide variation in wealth of farmers. The reasons for the variation seem as yet poorly understood (University of Birmingham *et al.*, 1998b, p.182).

Changes in crops grown

Crops currently grown are briefly presented in University of Birmingham *et al.* (1998a) together with changes in cropping systems since the mid-1950s. This is considered in more detail in Chapter 3.

Changes in waste processing for compost

Institutional changes in Hubli-Dharwad that have affected utilisation of urban waste are considered in detail in Chapter 2 and are outlined here only briefly. They are reported more fully in University of Birmingham *et al* (1998a, 1998b).

Waste collection management is changing. On an experimental basis, committees were set up to organise the collection of separated waste by casual workers. The organic matter is used for vermicompost and the inorganic matter put into the corporation bin. This experiment has met with only limited success. The Hubli-Dharwad Municipal Corporation (HDMC) recently has begun door-to-door collection of waste from commercial and residential properties. A tipper truck will be purchased to reduce the need for handling. Waste from the hospital is to be collected separately. The council hopes that the householders can be persuaded to use separate bins for different kinds of waste. The trial separation scheme has so far been of limited success as it is difficult to employ people, and households are unwilling to pay for collection The council may ban certain types of   waste   such   as   plastic   bags.

It is possible that HDMC may offer a discount to poor farmers for processed waste, but there are a number of difficulties:

- How can the extra cost to the HDMC be recouped?
- Who are the poor?
- Subsidies will be difficult to remove later
- There is increasing commercialisation of waste management. A commercial company has leased land from the municipality and plans to produce vermicompost. The company separates the waste which is then used for compost. Farmers are concerned about the higher costs of vermicompost as the unsorted USW is much cheaper.

    A number of institutional constraints and concerns remain:

- The increased pressure to become more environmentally safe.
- Financial constraints on HDMC.
- Doubts about whether the source separation scheme at community level will be adopted on a large enough scale.
- There are conflicting demands on HDMC by farmers and the commercial sector.

Summary of changes

The picture is one of increasing pressure on land, complex rearrangement of settlement patterns (not simply movements into the cities), reduced dependency on agriculture as a sole source of income, and perhaps some degree of intensification of farming systems. However, at this stage these are poorly characterised.

Principal stakeholders characterised

The stakeholders who are or could be concerned with changes in soil and water management are well understood. The project baseline studies, inception reports and final technical reports are particularly important sources. Some of the stakeholders for different aspects of soil and water management are shown in Table 5.4. Shaded cells under a particular activity are those groups who are affected by or who may have an interest in the activity.

There are records on land ownership which seem to be difficult to access. Little information exists on who is involved in land transactions. Government actors in land planning and other land management activities are obviously known locally, yet they seem to be largely ineffective and may not figure as important stakeholders (University of Birmingham *et al.,* 1998a, p.106-118).

The Census does not provide information on who owns lands, including absentee landlordism with rented plots or share cropping (University of Birmingham *et al.,* 1998a, p.23). However, the village surveys obtained some information. These provide only general impressions of what types of purchasers are buying land, whether it is farmers for other villages or urban dwellers buying land for investment or speculative purposes. Village informants quantified landowners in various categories for 1987 and 1997 (ibid, p.33). Land records exist which provide information on each plot of land within a village, but they are in several forms and in several places (ibid, p.116).

Table 5.4 Stakeholders for different aspects of soil and water management

PUI agricultural development generally[6]	Use of waste and sewage for composting - all areas	Sewage treatment	Urban expansion and land use changes
Taxpayers	Ultimate source of revenue, some are beneficiaries		
Municipal councils & national government departments	Administrators; waste managers; planners engineers. In Kumasi: Kumasi Metropolitan Authority	Administrators, planners; engineers. In Kumasi: Kumasi Metropolitan Authority	Kumasi: Kumasi Metropolitan Authority; Lands Commission Land Evaluation Board. Hubli-Dharwad Urban Development Authority (HDUDA)
Traditional leaders and local government			In Kumasi: chiefs District Co-ordinating Committees; Regional Co-ordinating Committees
Companies potentially or currently involved in waste recycling	Commercial recycling companies in Hubli-Dharwad.		
Farmers in general	Better off farmers may benefit from processed composted waste more than poorer farmers due to cost.		Farmers who are displaced.
Producers of waste such as poultry farms, dairies - potential extra income / reduction of disposal costs	Demand for manures may change (up or down), affecting income of manure producers.		

Table 5.4 (continued) Stakeholders for different aspects of soil and water management

PUI agricultural development generally[7]	Use of waste and sewage for composting - all areas	Sewage treatment	Urban expansion and land use changes
Farmers on irrigated land	No interactions reported yet	Those with access to sewage polluted stream water.	
Inorganic fertiliser marketing companies whose trade may be damaged by increased use of organics.	No interactions reported yet	Farmers using sewage waste streams use no inorganic fertilizers, but pesticide use increase (Hunshal *et al*., 1998).	
Research institutions (environmental scientists; economists; soil scientists; farming systems specialists; social scientists agronomists	Kumasi: University of Science and Technology (ILMAD); Environmental Protection Agency. Hubli-Dharwad: University of Agricultural Sciences, Karnatak University.		
Extension workers in ministries	No involvement yet, or only preliminary.		No involvement yet, or only preliminary.
Consultants, overseas agencies	Several, including DFID, FAO, IBSRAM.		
NGOs	Kumasi: BIRD; CEDEP; GOAN. Hubli-Dharwad: BAIF		
Banking and Rural Credit organizations	No involvement yet, or only preliminary.	No information	No involvement yet, or only preliminary.

Effects changes of land use, soil and water management upon livelihood strategies of resource-poor farmers

The specific strategies adopted by resource-poor households with regards to soil and water management have not been adequately characterised in either Kumasi or Hubli-Dharwad.

Effects of land use changes on poor in relation to soil and water management

As above, the effects of changes in land use on the poor have been poorly documented in Hubli-Dharwad. Non-farm employment has increased in the three taluka closest to the twin cities. This was particularly so for men (University of Birmingham *et al,* 1998a, ii. p.29). The greatest increases were in industrial and construction labourers working outside their villages. Construction workers were sometimes in brickworks and stone quarries outside the city (University of Birmingham *et al.,* 1998a, p.29), but these can activities can be assumed to depend upon a market for their outputs in the city.

Participation by women in the labour force increased particularly rapidly for women in the three taluka nearest to Hubli-Dharwad. However, female non-farm employment increased much more slowly than male, indicating that most women were finding work in the lower paid farm sector (University of Birmingham *et al.,* 1998a, p.19).

Relevant knowledge of strategy options for land use and production

Introduction

The emphasis has been on composting and the use of this and waste in soil ameliorants. Reviews of the use of waste generally have been undertaken by several teams and a summary of their observations is given below. The potentials for using waste for animal feed or aquaculture have not been adequately studied. However, quite a lot is now known about the processing of waste for soil amelioration composting, but there is still a need to continue trials of the most promising methods over several years. Potential for soil contamination over the long term, particularly in Kumasi, should be looked at more carefully.

Institutional as well as technical means of enabling the poor to benefit from composted waste have yet to be found. The municipalities have to manage disposal of waste anyway so perhaps the costs of producing compost from waste could be subsidised. It could be argued that the future of soil fertility maintenance has to be with combinations of organic matter and inorganic fertilizers. Not enough is known about the optimum combinations of these from the points of view of economics, soil fertility, soil physics and toxicity.

Irrigation with contaminated water should be an important theme for future work. The contaminated water is high in nutrients and stream water is more available to poorer people than borehole water. Possible research topics include: ways of using or managing the water in-field, safely (as practised in China and elsewhere), characterising risks, benefits and beneficiaries, effects of sewage

treatment upon cropping system nutrient balance. The use of sewage contaminated water could perhaps be seen as part of the dynamic changes in the PUI and only adopted during early phases of development, to be phased out later as the sewage stream is cleaned up or consumer resistance increases.

Green manure does not have much of a future in the urban environment unless hedgerow material can be used (e.g. *Tithonia diversifolia*) but farmers will probably find the extra labour requirements difficult to meet. Application rates of 10 tonnes / ha are suggested; even for *Tithonia* there would be a problem of obtaining sufficient material for any but the most valuable (probably horticultural) crops.

The development of farm equipment, tools and post-harvest processing innovations that proximity to workshops in the urban centres should be able to encourage. has been almost totally ignored. For example, the development of a low cost compost or manure transporter for use round Kumasi may encourage uptake of use of poultry manure (also see Chapter 3).

Other areas where not enough is known include:

- Surface and groundwater hydrology in the areas and how urban expansion is affecting the water table, pollution, seasonality of flow, or yield.
- Interaction of sewage contaminated water and fish in ponds, of which there are > 100 around Kumasi.

If farmers are to steward the land more enthusiastically, the improvement of security of tenure is an important area that needs to be addressed, especially in Kumasi.

Soil maps and land capability and land use maps are not adequately used in the "planning" - if any takes place - of urban expansion. Use of GIS keeps maps and mapping among the elite. The whole process of land capability and land use mapping has to be taken to the people in the villages and the urban fringe. There has been considerable experience of the participatory production of soil and land use maps elsewhere. GIS has a rôle but it should not become an end in itself (see Chapter 7).

Use of waste and sewage in the PUI - literature reviews

Introduction

There have been a number of reviews of use of waste and sewage in the PUI. In 1998. Allison *et al*. (1998) conducted a review of the use of urban waste in the PUI in general. Other documents have included reviews of the topic. For example the Inception Report (University of Birmingham *et al*., 1998c) and Final Technical Report (Nunan, 2000) of the "Urban Waste Utilisation Project" (R7099) noted that despite waste being widely used in India, there are few documented sources of information, especially on the quality of USW as a soil amendment such as its contribution to soil nutrients and the human health aspects. It was clear that research into the health risks of using organic waste such as that derived from USW had been minimal.

Examining the use of waste around Kumasi, Harris and Smith (1998) provided a useful literature review, outlining the sources, ownership, utilisation, economic value, market, distribution system of processed products, soil fertility value, competing uses of waste, constraints to utilisation, processing, alternatives to processed waste.

Potential for use of waste in agriculture

Summarising the findings of the reviews conducted by Allison *et al*. (1998) and Harris and Smith (1998) they found the following different uses for waste:Waste as animal feed (especially in urban as opposed to peri-urban environments).

- Solid municipal waste, nightsoil and sewage as constituents of soil improvers
- Waste as fuel.
- Waste for aquaculture (faeces encourages growth of algae, rotifers, crustaceans).
- Waste for mushroom, yeast, algae growing.
- Waste water for irrigation.
- Recycling of waste.

It may be noted here that so far, only waste solid waste as soil improver, nightsoil as soil improver and (to a lesser extent), waste water for irrigation has been examined in the PUI projects even though waste as animal feed was one of the   original   purposes.

Technical benefits of composted waste

What little work has been published on the fertility value of composted USW indicated (Harris and Smith, 1998, p 24; University of Birmingham *et al*, 1998c) that compost improved the physical and chemical properties of the soil, reduced disease and if applied to the surface as a mulch, reduced weed growth and conserved soil moisture. Composted USW affects the physical soil properties through increased soil porosity (and thus increases infiltration of rain, and decreases runoff and erosion) and increased water holding capacity and aeration. Soil structure (which improves water holding capacity and decreases susceptibility to soil crusting) is improved.

Composted waste also supplies primary nutrients (quoted values for USW from India are 0.5% N, 0.3% P, 0.3% K (Nunan, 2000, p.33), increases enzyme activity and decreases leaching of nitrogen. These benefits can be improved by adding rock phosphate, urea, and/or inoculating with *Azobacter chroococcum* or *Aspergillus awamori*. Wood ash in compost can reduce Ca deficiency (for example, groundnuts at flowering) or K deficiency (for example, tomatoes at flowering). Rice husks in compost can reduce silicon deficiency. Adam (2000b) notes that the uptake of nitrogen is more efficient from inorganic fertilisers than organics though the uptake of phosphorous is more inefficient. As crop residues constitute 90% of the total nutrients, proper recycling of crop residue is beneficial for soil nutrition. Modalities for use, rates, combinations for composted waste are seriously under-researched.

It was also reported that composted waste can act as a delivery agent for the microbial control of pests (citing citrus in California) and so can have an inhibiting effect on soil borne plant pathogens. It also contributes to the suppression of nematode populations. Holland *et al.* (1996a) quotes several authors who suggest that organic mulch controls septoria leaf spot and that green mulch controls nematodes.

Factors affecting use of waste in soil ameliorants

The review (Allison *et al*., 1998) goes on to examine the factors affecting the use of waste in agriculture such as type of agriculture (farming system, rural livelihoods, crops, livestock); markets (for farm produce and for waste); knowledge, perceptions, preferences, social and cultural factors; land tenure and availability, and geography. It also discusses the institutional and policy factors. A bibliographical database on urban waste is included.

Constraints and opportunities for use of waste as a soil ameliorant in Hubli-Dharwad

The R7099 Inception report (University of Birmingham *et al*., 1998c) reviews what little documentation on use of waste exists in India. It notes that the informal sector (mostly poor people) plays an important role in the southern cities. The gender dimensions of waste collection are poorly understood though it has been pointed out above that women are increasingly entering paid employment including farm labour. As source separation within households and waste picking generally is done by women (and children), changes in the labour dynamics or the market for organic waste will affect women's livelihoods.

"Wet" organic waste is considered to be religiously polluting so waste pickers tend to be poor and / or low caste. Cultural concerns about aesthetics and odour are important constraints. Waste pickers prefer to work independently and not to be employed formally. However, there is considerable potential for NGOs to link the formal (private and municipal) and informal sectors.

Source separation is the key factor in producing good quality compost. To change habits, education is important as most separation in India is at household level. However household commitment to separation and collection has been poor in Hubli-Dharwad. Households do not want to make additional payments for more organised waste collection as it is considered to be the job of HDMC.

Some centralised composting plants were built in the 1970s and 1980s but many of these closed due to high production costs (land, labour, transport); inadequate maintenance and poor marketing of composted products.

Neighbourhood composting schemes exist in some areas of India - waste is collected in separate containers and committees organise collections by people employed by the scheme and who are funded by the households themselves, by NGOs or by the Municipal Authorities.

The use of waste to provide soil conditioners are affected by a number of economic, technical, human health, cultural and institutional constraints (Harris and Smith, 1998). These constraints affect resource-poor farmers particularly.

There may be alternative uses for waste that may be more profitable. Costs of labour (if available), separation, collection and transport may be too high. Increasing labour shortages / costs (due to competition from other employment opportunities) occur at dump sites (to dig pits) and for farmers (to empty pits and sort the waste). These economic factors may make compost unaffordable by

farmers especially if alternative (inorganic) soil ameliorants are available more cheaply. Commercial vermiculture is now increasingly common in India to compost wastes and the product is sold to gardeners and farmers.

Composts are in increasingly short supply. Because of this, some farmers till the soil earlier to adapt to changes in availability of composts. Also the use of animal manure for composting is becoming more problematic because of:

- Continuing competition for its use as a fuel as well as compost component;
- A declining availability of animal manure as a result of mechanisation;
- Proposed legislation that would evict cattle from cities of over 500,000 inhabitants.

Farmers may thus turn to inorganic fertilizers although the above also means that the use of USW for compost may be more attractive. Unfortunately, the declining quality (for example, because of increasing amounts of plastic) makes use by farmers decreasingly viable without source separation. The declining quality (especially increasing amounts of plastic) means that farmers without tractors are increasingly reluctant to hire them for low quality material. Only 35% of municipal waste is now compostable.

The possibilities of phyto-toxicity (ammonia "burning", salt, phenolics, low molecular weight organic acids) or nitrogen immobilisation due to high C:N ratios mean there are some technical risks involved in the use of waste.

There are obvious risks to human health and safety and environmental pollution. However, research has established that composting kills off almost all pathogens if the temperatures of the compost is high enough or the waste is stored for periods of about a year (University of Birmingham *et al*., 1998c, p.17). There is, nevertheless, a need for more research to establish the minimum requirements.

Perhaps the greatest constraint is the lack of institutional support, especially in the area of legislation regulations and control of waste disposal and environmental pollution and in such issues as land tenure (as farmers are reluctant to invest in insecure holdings).

Despite these constraints, the Hubli-Dharwad inception report (University of Birmingham *et al*., 1998c) found that farmers were quite experienced in using composts, including USW but that it was the wealthy farmers who have been the main purchasers of compost. In particular, the proposed vermi-composting of

USW by commercial sector (in Hubli-Dharwad) will be even less accessible to resource-poor and marginal farmers.

Processing of waste into compost

The advantages of composting are that it:

- Sanitises waste.
- Reduces waste volume.
- Reduces phytotoxic properties (*e.g.* High C:N ratio).

Aerobic systems are favoured as anaerobic systems produce methane (although if controlled, this could be captured in the form of "biogas"), use more complex technology, are more difficult to manage and are slower than aerobic systems.

Aerobic systems include:

- Open systems.
- Windrows in lines 2 to 3 m high and turned regularly.
- Static piles aerated using pipes (pumped air or atmospheric pressure).
- In-vessel systems (healthier and quicker but expensive).
- Vermicomposting.

The review (Harris and Smith, 1998) discusses the pros and cons of various scales of composting from household to municipality level (Table 5.6) and different management / financing options (private, public). Processing constraints include: land availability, technology and management required (such as sieves and magnets needed for larger scale operations), climate, matching supply with capacity, lack of institutional support, legislation, regulations, control, and public acceptability.

Recommendations

Harris and Smith (1998) recommended increased use of poultry manure and compost, application to vegetables and other high value crops, and municipal and community level composting.

Urban waste as a soil conditioner around Kumasi

The baseline study (Holland *et al*., 1996a, p.52) and the consultancy report (Harris and Smith, 1998) give evaluations of waste around Kumasi. The latter considers:

- The present availability of waste (Holland *et al*., 1996a ,Table 5.4).

- The present utilisation of waste (Holland *et al*., 1996a, Table 5.6).
- Alternative uses of waste (Harris and Smith, 1998, p.39).
- Potential for development (Harris and Smith, 1998, p.39).
- Suitability for different farming systems (Harris and Smith, 1998, p.43).

The availability of waste, possible management for agricultural purposes, usefulness for different farming systems and potential use of poultry manure in different farming systems are summarised in Tables 5.5 and 5.6. Data (annual figures) provided by Adam (2000b), quoting Kindness in Brook (2000) and the Baseline Study (Holland *et al*., 1996a, p. 52-57) have also been included.

Researchable constraints (Holland *et al*., 1996a, p. 65) are:

- Quantification of potential value of organic wastes for farmers.
- Investigation of potential use of food wastes (compost?,cattle-feed?).
- Development of further USW based composts.
- Investigation / development of organisation of waste processing / transport / privatisation / incentives.

The following three tables (Tables 5.5 to 5.7) present, in summary form, availability of waste, possible strategies for its use (particularly the potential for use of composted urban waste) in agriculture around Kumasi.

Animal waste in composts around Kumasi

Of the 4,800 t of inorganic fertilisers marketed in Kumasi, only 10% is used in the peri-urban area. Very little of the animal manures available is used as fertiliser except poultry manure. The main constraint seems to be transport costs.

Of the 34,000 t of poultry manure produced around Kumasi annually, about 67% is used as fertiliser in the peri-urban area. A summary of results of trials with poultry manure is presented in Chapter 3. Table 5.8 summarises the potential for use of poultry manure in farming systems around Kumasi.

The increased use of pig manure is suggested as a possibility in several reports (*e.g.* Nunan, 2000). Several authors have mentioned that pig manure could be more extensively used if the pigs were reared in pens.

Table 5.5. Availability of waste around Kumasi

Material	Availability	Comments
Municipal, domestic and commercial waste	425 to 500 t d^{-1} (100,000 t y^{-1})	Figure represents only c. 45% of the total. OM is 87% in Accra (75 to 90%? in Kumasi) but no data on spatial or temporal variation. Also used for land reclamation and animal feed in Kumai but mainly dumped in tips or land fill sites. Siting of latter a continual problem. Contamination of surface and groundwater resources is expected but there has been little research. Increasing problem of accumulating waste in the districts around Kumasi. KMA propose to compost waste as part of their waste management plans but the market for composted waste has still to be established. Because KMA has to dispose of waste, it may be economic to subsidise farmer use of composts produced.
'Black soil' (material decomposed *in situ* at dump sites)	?	Use is limited. Collected by individuals for topsoil / horticulture; time consuming to extract.
Night soil and sewage sludge	336 m^3 day^{-1} (250 to 350 t d^{-1}; 100,000 m^3 y^{-1})	43 truck loads. Present sewage facilities very inadequate. Mainly collected and dumped into rivers by municipality. Obvious hazard downstream. Mixing with sawdust has been suggested. Trials on combining USW or sawdust with nightsoil were suggested.
Market & hotel waste	80 to 85 t d^{-1} (20,000 t y^{-1})	Estimated to be 80% organic. Mostly from central market; contaminated by plastic bags and faeces. Mainly dumped. Mixing with sawdust has been suggested.
Slaughterhouse waste	Probably low	Disposed of in drainage system, horns used for crafts, bones for glue
Sawdust	15,000 t stockpile + 40 t day^{-1} (6000 t y^{-1} ?)	Use for compost thought to be unviable. Used for poultry bedding. Some industrial use.

Table 5.5 (continued). Availability of waste around Kumasi

Poultry manure	34 t day^{-1} for large units	There are c. 300 poultry farms around Kumasi of unknown size. Collection for compost could be a problem but many poultry units will deliver for cost of transport only (c. C300 to C 1000 per tonne?). Deep litter system using sawdust & shavings increases C:N ratio. Trials needed. Farmers reluctant to use as considered "unclean".
Other animal manures	?	Unknown potential for use of sheep, goat, cattle, pig, manure. Some used for fish feed.
Brewery waste	Low (6,000 t y^{-1} of grain; 30 t y^{-1} of yeast)	Some used for livestock feed.
Soap factory	Very low	
Food processing: palm oil by-products	135,000 t y^{-1}	Construction (palm fibre).
Food processing: cassava peel	?	Some used for livestock feed.
Food processing: cocoa shell	?	Fuel
Crop residues		GOAN (Ghana Organic Farming Netowrk) have been demonstrating and training farmers in the production of compost. It contains dry and fresh vegetables, cut grass, household waste and wood ash. The compost is produced in heaps (Field trip to Duase, Final Workshop, KNRMP). Holland *et al.* (1996a) reported that composting was not common around Kumasi. Demonstrating composts may be a better strategy than trying to introduce people to composting

Table 5.6. Possible strategies for the use of waste in agriculture around Kumasi.

Strategy	Comments
Use of urban waste	Does not include the required 'composting' aspect for crop protection. Limited opportunity to manipulate quality. Major disadvantages as discussed above (Table 5.5)..
Urban home composting	Often traditionally practised in an "unintentional" way with back garden heaps or pits. Mainly household waste/ livestock wastes some crop residues. Limited capacity to deal with large amounts of urban waste. Many urban producers don't have gardens to use the compost. Resistance because of attraction of flies. Rats and snakes. Relies on raising awareness.
Peri-urban backyard composting	Widely practiced in India. Limited opportunity to manipulate quality. Doesn't address the problem or potential of urban waste.
On-farm composting	Usually relevant to farm wastes from livestock and crop residues hut may also include household waste. Labour a major constraint. Doesn't address the problem or potential of urban waste.
On-farm composting with waste input from peri-urban community or urban areas	Has worked in some areas where farmers receive/collect wastes. Offers possibility of selecting higher value wastes for co-composting. Labour a major constraint, only possible with minimal labour requiring techniques. Likely cultural constraints to handling certain waste types. Transport a major problem: contrary to principle of composting as close as possible to site of waste production/ collection.
Peri-urban community composting	Doesn't address the problem or potential of urban waste. Very few villages have their refuse collected by the local authority or district assembly: therefore, waste is available Land is unlikely to be a constraint. Rubbish dumps are currently usually maintained by the women in the village: may need some additional/ voluntary labour. Limited opportunity for commercial development.
Peri-urban community composting with other urban & peri-urban input	Many urban producers don't have gardens to use the compost. Offers possibility of selecting higher value wastes for co-composting such as surplus chicken manure some of which is available in peri-urban areas. Offers possibility of deliberately manipulating composting process to enhance crop protection aspects. Likely cultural constraints to handling certain waste types. Transport a major problem; contrary to principle of composting as close as possible to site of waste production/ collection. General pros and cons of community composting discussed below.

Table 5.6.(continued). Possible strategies for the use of waste in agriculture around Kumasi.

Strategy	Comments
Urban community composting	Successful in some areas. Requires effective community organisation or NGO activity; more difficult than in village communities. Difficulty in sustaining voluntary labour. Limited commercial prospects. Likely mismatch between producers of waste and users of compost. Appropriate in areas inaccessible for refuse collections or where collections are unreliable. Offers possibility of selecting higher value wastes for co-composting livestock, market, organic household. agro-industrial wastes. Offers possibility of deliberately manipulating composting process to enhance crop protection aspects. Waste separation at source .ay be possible in higher income areas. May encounter resistance from municipal authorities who see waste management as their business. Likely to encounter difficulties in access to adequate land and water resources. May experience difficulty in disposing of low value non-compostables in the waste. General pros and cons of community composting discussed below.
Private enterprise (small/ medium scale)	More likely to be on urban fringe than in outer peri-urban area. Poorly understood waste streams. Currently very poorly developed market for organic fertiliser. Offers possibility of selecting higher value wastes for co-composting; livestock market; organic household; agro-industrial wastes. Offers possibility of deliberately manipulating composting process to enhance crop protection aspects. Waste separation at source may be possible in higher income areas; Requires significant investment, even for low tech options.
Municipal large scale	Land available and secure. Assumes municipal collection service. Close link, physically and administratively, between collection/delivery sites, composting and landfill. Possible subsidy, direct or hidden from municipal authorities. May generate revenue at least to offset costs. Likely to have (or train) staff to a reasonable technical level and better able to handle more difficult wastes such as nightsoil + sawdust. Can achieve good sanitation of wastes. Possible separation of major categories only, such as market wastes, for composting. Large volume production, but depends on maintaining level of technology. Tends to become bureaucratic and inefficient.

Table 5.7. Potential use of composted urban wastes in different farming systems around Kumasi.

Farming system	Potential for use of composted urban wastes	Opportunities & constraints
Bush fallow mixed	Very low	Traditional bush fallow system for subsistence plus surplus. Limited current use of inputs.
Sole crop cereals	Low	Bush fallow system but often more for cash income. Limited fertiliser inputs, relatively large scale farms. Likely to encounter major logistical constraints. Very impressive short-term soil fertility crop protection benefits would have to be demonstrated and very favourable cost-benefit relationships .
Sole crop vegetables (dry season)	Low/ medium	Sometimes opportunistic cultivation as part of bush fallow rotation. Opportunities and constraints as above. Greater requirement for pest and disease control and higher value of crops may increase potential.
Sole crop vegetables (irrigated)	Medium/high	Especially where this forms an intensive use of land over several years.
Specialised valley-bottom cropping	Medium/high	Continuous cropping of cash crops close to urban markets and sources of compost. Considerable potential for increasing yields. Likely to be favourable cost-benefit relationship.
Tree crops	Low/ medium	Perennial crops which can benefit from applications as mulch.
Backyard farms	Medium	Continuous cropping, mixture of perennial and annual crops. Opportunity for long-term building of soil fertility. Production may be mainly for home consumption with less concern for yield and less willingness to purchase/ transport centrally produced compost. Natural place for using products of home compost and small scale community compost products.

Table 5.8. Potential use of poultry manure in different farming systems

Farming system	Potential for use poultry manure	Opportunities & constraints
Bush fallow mixed cropping	Very low	Limited current use of inputs.
Sole crop cereals	Medium	Less logistical constraints than with compost. Growing commercial agricultural sector?
Sole crop vegetables (dry season)	Medium	Possibly as an alternative to chemical fertilisers.
Sole crop vegetables (irrigated)	Medium / high	Especially where this means an intensive use of land over several years.
Specialised valley-bottom cropping	Medium / high	Continuous cropping of cash crops close to urban markets and sources of compost. Considerable potential for increasing yields. Likely to be favourable cost-benefit relationship.
Tree crops	Medium	May be selected because of perceived medium / long term effect of manures
Backyard farms	Medium / high	Convenient and easy to use in the same way as a fertiliser

Source: Harris and Smith (1998).

Potential for use of waste as a soil conditioner around Hubli-Dharwad

The potential use of municipal solid waste (USW) as a soil conditioner around Hubli- Dharwad was investigated by the " Urban Waste Utilisation Project" (R7099). The aim was to investigate not only technical aspects but more importantly the institutional and policy issues. These latter have been summarised and evaluated elsewhere.

The trials

Field trials were conducted on 10 farmers fields in two villages, following composting trials conducted in Phase 1 of that project. Details of the pit and compost preparations are given in University of Birmingham *et al.* (1999a, 1999b) for Phase 1 and for Phase 2, respectively. Only composts generated in Phase 2 were used for field trials. The treatments used for the composting trials were:

- Sorted USW [Phases 1 & 2].
- Sorted USW + 25% Distillers Sludge (DS) [Phases 1 & 2].
- Sorted USW + vermicomposting (V) [Phases 1 & 2].
- Sorted USW + 25% night soil (NS) [Phase 2 only].
- Sorted USW + 50% DS [Phase 1 only].
- Sorted USW + 75% DS [Phase 1 only].
- Sorted USW + vermicomposting (V) + 50% DS [Phase 1].
- Sorted USW + *Azospirillium* bacteria + rock phosphate [Phase 1].
- Sorted USW + 5% cattle manure [Phase 1 only].

In the trials with distillers sludge and night soil, 1 kg culture of each of the bacteria *Bacillus polymyxa* (phosphorous solubilising) and *Azospirillum* spp. (nitrogen fixing) were added/t USW (University of Birmingham *et al.*, 1999a). It was apparent in the trials that 90 days was a sufficient length of time for the composting to take place but there is a need to determine the optimum time and conditions. A summary of the chemical analyses of the various treatments compared to pit compost (PC) is given in Table 5.9.

No treatment stands out in terms of nutrient levels and their performance from a nutrient point of view would depend on the soil and crop. Generally, the additions of night soil or brewers sludge improved the USW as did vermicomposting. Nitrogen and potassium were both lower for all the treatments than for PC and only USW + V and USW + NS had slightly higher P values. The EC indicates that all the treatments are marginally saline. There may be some potential for salt build up, especially in the black soils which have impeded drainage.

Levels of Mg, Cu and Mn are all much higher in the treatments than the levels in PC but are not thought to be a problem. These may be beneficial though

little is known about the existing micro-nutrient status of the soils or the uptake by the crops. More research on heavy metal aspects of USW based products is required. In particular metals such as mercury, lead, cadmium and chromium need to be assessed.

Table 5.9. Comparison between properties of farm yard manure (probably pit compost) and sorted municipal solid waste in Hubli-Dharwad experiments.

Analysis	FYM	Comparison of treatments with FYM
pH	7.2	all slightly more alkaline (USW alone was the highest (8.0)
EC ds m^{-1}	0.2	5 to 13 times higher (USW + DS highest)
N%	1	40% (USW alone) to 70% (USW + DS) of PC
P%	0.5	USW & USW+DS were 70% of PC, USW+V & USW+NS were 10 to 20% higher
K%	0.8	all 25% to 30% higher than PC
Ca%	0.2	all 15% to 24% higher than PC
Mg%	0.15	all 5 to 12 times PC
S%	0.2	25% less to 25% higher than PC
Cu ppm	0.45	about 20 times PC
Mn ppm	110	15% to 25% of PC
Fe ppm	35	about 50% to 70% of PC
Zn ppm	25	about 20% of PC

Source: Nunan (2000)

It was estimated (University of Birmingham *et al*., 1999a) that USW itself in Hubli-Dharwad consisted of:

- 35% compostable waste.
- 35 to 40% of plastics, glass, rubber.
- 15 to 20% of building debris.
- 5% of metal.
- 5 to 10% of woody biomass.

The proportion of the latter four items vary by season. No actual analysis of constituents or chemical analyses for the USW, night soil or distiller's sludge used are presented. This may make applications of the research to other parts of the world more difficult. It may also have clarified the most important processes involved if further treatments in which the bacteria were added to the USW alone[8] was included and if the two species of bacteria were added singly as well as together. It is difficult to know to what extent the improvements observed are due to the bacteria and those due to the night soil or distillers sludge.

Comparison of treatments

Overall performance of the different treatments on four different crops in 10 villages (Nunan, 2000, p.35) were (in order of performance):

- Sorted USW + night soil.
- Sorted USW + vermicomposting.
- Sorted USW alone.
- Sorted USW + distillers sludge.
- Farmer's own practice.

The trials each ran for only one season but it was suspected that benefits were not necessarily obvious in the first season. Longer term trials would be needed to address this question. Results are presented in Chapter 3 (Table 3.1). Night soil or vermi-composting seem to be the most advantageous treatments and this was supported by analyses of nutrient uptake.

Social and institutional aspects

The research on waste (Nunan, 2000) reinforced the view that a tradition of using compost exists in the area of Hubli-Dharwad. In fact farmers prefer organic fertilisers to inorganic sources of nutrients. However, there are a range of constraints that discourage the expansion of waste use such as cost, transport and decreasing quality.

One of the most important constraints is that it is difficult to achieve significant commitment to separation at source at household level. Thus, separation is an important bottleneck, and consequently the different types of waste are not being collected separately. The municipality has an inadequate waste collection system and the dump sites are not managed / sited in an environmentally sensitive way.

Traditionally, farmers are allowed access to USW tips. Some are concerned that increasing commercialisation may halt this practice (though as pointed out

above it is becoming less economic for farmers to collect and use USW). The private sector and NGOs could be persuaded to become involved in the separation, processing and distribution of waste products and that there is a range of products sold at different prices.

HDMC is addressing some of these problems but the R7099 project report emphasises that an integrated systems approach to waste management in which waste is perceived as a resource, is required. There is a range of different sources and uses of waste but there is a need to better understand the interactions between these. Different methods of composting need to be explored (as turning composts in pits is difficult) and the health and management of incorporation of night soil needs further exploration.

Use of municipal waste around Kano, Nigeria

It is interesting to compare the situation in Kumasi with that of Kano in northern Nigeria. Lewcock (1995) describes an earlier peri-urban DFID funded project there (Lewcock, 1994). He made the following points:

- Use of waste for agriculture is well established and has been practised for several centuries in Kano.
- In the 1960s, 25% of fertiliser needs in the peri-urban environment were met by reuse of municipal waste.
- By the 1990s, the area is which waste was used had increased, though after the replacement of the traditional donkey mode of transporting the waste with municipal tipper trucks in the 1980s and the subsequent deterioration of the lorries, supply difficulties were being experienced (projects developed for Hubli-Dharwad or Kumasi should note this).
- The waste was composed of:
  - Street and household waste;
  - Unmixed manure;
  - Other material (such as tannery waste, abattoir offal, waste water).
- The Challwa River is heavily polluted with household and industrial waste (as is the case in many other PUI), and it is an important source of irrigation water for horticultural crops.
- As in Ghana and India, the urban waste has decreased in quality (such as increased proportion of plastic bags).
- The perceived benefits, methods of use and preferences are similar to Hubli-

Dharwad and Kumasi.
- As in Hubli-Dharwad and Kumasi, there is increasing private involvement.
- Waste is not formally composted in Kano and the affordability of composted waste by resource-poor farmers is questioned.

Use of sewage-contaminated water around Hubli-Dharwad

Introduction

An examination of the use of sewage contaminated stream water was not a specific purpose of the Hubli-Dharwad PUI projects. However there have been some incidental outputs such as Hunshal *et al*. (1997), a section in University of Birmingham *et al*. (1998d)[9] and comments in the baseline study (University of Birmingham *et al*., 1998a). There is no treatment of sewage around Hubli-Dharwad, even though it is estimated that 60 million litres of sewage per day are produced (Hunshal *et al*., 1997) Some liquid presumably drains to the water table, but much of the solid and liquid sewage finds its way into the surrounding water courses.

Impact on weeds and pests

A major drawback of the use of sewage contaminated water is increased levels of weeds and insect pests on crops (which, because of the high value of the crop, encourages farmers to use organo-phosphate/insecticides, often with no protective clothing).

Water quality

The stream water does not suffer from heavy metal contamination due to the absence of heavy industry in the area. However, total suspended solids are high   (110 mg l^{-1}) and dissolved solids are also high (780 mg l^{-1}) and could affect salt sensitive crops[10]. The nitrogen concentration was around 12 ppm which partly explains why the yields of stream irrigated crops are (anecdotally) 25 to 30% higher than those irrigated from boreholes. A summary of some of the chemical analyses of the water (Hunshal *et al.,* 1997) is given below in Table 5.10.

Table 5.10 Properties of sewage contaminated irrigation water, Dharwad

Parameter	Quality assessment
pH	neutral to slightly alkaline
Biological Oxygen Demand (BOD)	2 to 19 times acceptable limits for potable water
Chemical Oxygen Demand (COD)	2 to 9 times acceptable limits for potable water
Suspended solids	Good: 20 to 120 g per tonne
Dissolved solids	some samples are marginally saline
Chlorine	slight to moderate chlorine hazard for crops

Source: Hunshal *et al*. (1997)

Health aspects

In a brief and poorly thought out study of 40 men in two villages near Hubli-Dharwad where fields were irrigated with sewage contaminated stream water (Hunshal *et al*., 1997), it was reported that the water had an adverse affect on irrigators' health. However, the men were simply examined for any health problems. Consequently many of the diseases listed (such as varicose veins!) are certainly not water borne. The conclusion that conjunctivitis, and dermatological and gastro-intestinal diseases are higher in populations exposed to contaminated irrigations water needs to be treated with some caution. Furthermore, the study had no control (40 men or women who had never been exposed to contaminated irrigation water) and thus the study would seem to be inconclusive. However, samples of irrigation water taken from one village exhibited the following micro-biological analyses:

Total bacterial growth:	12×10^6 ml^{-1}
E. coli (unspecified type(s)):	4×10^5 ml^{-1}
Total fungi:	2.8×10^4 ml^{-1}

Economic aspects of using sewage contaminated water

Producing vegetables for sale during the dry season means that farmers can sell for three to five times the kharif season prices. Also, as pumping from a water course is cheaper than from a borehole, it is more accessible to farmers with fewer financial resources.

It is not clear what the status of HDMC's attempt to get finance for processing is and what their treatment preferences would be.

Research requirements

This topic needs further research, especially: -

- Quality and quantity of sewage contaminated water available;
- Groundwater monitoring for contamination (wells and boreholes);
- Soil nutrition and toxicity aspects;
- IPM methods for managing the relatively high levels of pests;
- To clarify the human health hazards.

Sewage contaminated water around Kumasi

Kasanga (1998, Appendix 7) presented some analyses of water in the River Oda, at the confluence of the R. Oda and R. Seisa, at the public water draw-off point for the R. Seisa and R. Oda and at a point 100 m away from the public draw-off point. The water is slightly to moderately saline for irrigation purposes. BOD and COD are generally borderline moderate though the COD at one site was high. The Appendix refers to an (un-named) report which found that R. Seisa contained bilharzia and Guinea Worm vectors.

Green manures and mulches

Only a brief account of a trial with *Mucuna* sp. (species not mentioned) as a green manure is reported (Quansah *et al*., 2000). No details of application rates or trial design are given. It is concluded that:

- Mulches reduce evaporation by keeping surface cool and so conserve moisture.
- Yields are better (than slash and burn).
- Insects may hide in the mulch.
- Farmers are aware of the benefits of mulching.

There is clearly a need for better designed trials with Mucuna and other green manures and mulches. However it seems unlikely that green manures will pay a significant part in improving soil fertility in the PUI where land and labour are in such short supply.

Potential for using slaughterhouse waste in compost

Farinet and Dioh (1998) at a conference on peri-urban agriculture in sub-Saharan Africa in Montpelier described the 'Transpaille Process' developed by CIRAD for the production of biogas and compost "blocks". The blocks are composed of 75% compost and 25% sand with small amounts of fungicides and water-retaining chemicals. Seeds are planted and raised directly in the blocks. The blocks are increasingly used by peri-urban agriculturalists around Dakar in Senegal. The process could be tested in Kumasi.

Natural resource management at a watershed level (Kumasi)

The "Kumasi Natural Resource Management at the Watershed Level" Project (R7330) commenced in 1999 with the purpose of developing a framework for sustainable and equitable water resource management. It sets out to do this through participatory research and traditional monitoring methods (CEDAR, 1999, p.9) at a watershed level. The project will concentrate on examination of water resources in two sample watersheds in the Kumasi area (Owabi and Sisa-Oda). The project will minimise primary data collection and seek rather to integrate and collate what is already available. One aim will be to investigate how catchments upstream of Kumasi affect Kumasi and how Kumasi affects rivers downstream. PRAs will be used to characterise villages using transects, group narrative discussions, diagrammatic representations.

The project will also parameterise (using existing or easily collected data) diagnostic frameworks which will assist in identifying likely consequences of land use and cover changes or point pollution events on the hydrological and soil erosional systems. It is assumed that changed use will lead to pollution or land degradation (but this is not necessarily the case). Assessments will include: rapid field assessments, conceptual models and GIS manipulation, lumped parameter statistical models, distributed process-based simulation models; mainly the first two. Approaches to assessment of erosion risk, river network pollution and groundwater pollution models using GIS methods are discussed.

Although research into natural resource management at a watershed level may produce useful results, it seems unlikely at this stage that the administrative institutionalisation of natural resource management at a watershed level is a viable strategy.

The R7330 Inception Report (CEDAR, 1999) gives a list of further work required:

- Comparison of water quality sampling with perceptions of pollution which may lead to alternative, low-cost, management strategies.
- Land use changes and effects on the environment and health.
- Development of a methodology for monitoring land use changes.
- Basic hydrological data.
- Water use and management.
- Waste management, siting (and alternatives) and the effect on the environment.
- Tree planting data (or promotion).
- Information on relationships and responsibilities of government and local institutions vis-à-vis water / refuse / sewage.

Participatory planning

Participation needs to go further than the use of PRAs to help in characterisation of an area (Brook, 2000, p.13). In two of the case study villages, PRAs were undertaken to determine natural resource development priorities. Proposals from villagers included:

- Village level planning of village layout.
- Construction of a market.
- Protection of stream.
- Re-siting of refuse dump.
- Improved sanitation (latrines).
- Bore-hole and hand pump.

The villagers, with minimal help, subsequently undertook a stream protection project and a well construction project. This illustrates the need for increased emphasis on participatory methods. Little seems to have been done about the development of village level planning, the formation of self-help

groups, institutionalisation of participation at village level despite the fact that the topic has been raised often during the workshop and elsewhere.

Formal planning and land management

Williams (2000) stated that in Kumasi, planning in the peri-urban areas should pay more attention to:

The possible loss of good agricultural land to housing (good agricultural land, especially irrigable land needs to be preserved);

- The loss of fuel wood and timber resources (tree belts (for fuel and windbreaks) around villages should be established and maintained, although it is not suggested who would be responsible for this;
- The impact of sand winning and quarrying on the environment and potential benefits (it is possible that sand winning sites be used for waste disposal);
- Soil erosion undercutting houses.

The mechanisms and technical inputs (GIS, soil/land classification maps) for such planning are not mentioned.

Priorities identified at workshop on urban and semi-urban agriculture, Accra, August 1999[11]

Some of the priorities for future research identified at this conference that relate to soil and water management are summarised below.

Water

Agricultural production should be made safer with focus on institutionalised water quality monitoring (including agrochemicals where necessary) and certification programmes, which should be transparent for the farmers. Sources of pollution should be identified and legal disincentives addressed for point source polluting activities (car wash facilities etc.). Community-based water management in urban and PU areas could be supported with community-based water treatment technology.

Sustainable use of lowlands (wetlands) should be developed, including:

- Ecological and hydrological impact studies of wetlands used for urban and peri-urban agriculture,
- Participatory technology development for urban and peri-urban wetlands.

Soil

The (community) knowledge bases on soil fertility decline and soil contamination in peri-urban farming systems and on the safe use of compost and adequate application methods including the monitoring of pathogenic contamination due to the use of non-matured compost, needs to be improved.

Use of waste and nutrient recycling:

- Gain an understanding of nutrient flows in existing PU farming systems.
- Typology of farming systems.
- Mapping nutrient flows in different farming systems.
- Attitudes, perceptions, and demand for waste stream products for soil fertility improvement within different farming systems.
- Quantify the amounts and value of materials available and assess the agricultural potential of urban waste materials by investigating.
- Different storage options, application rates, and mixtures.
- Long-term benefits, not just short-term fertilising value (may require methodology development).
- Short- and long-term negative effects on soil quality & fertility.
- Specific applications for different crops.
- Develop & test appropriate waste processing technologies for a range of purposes that are sustainable given current resource constraints.
- Improve research uptake and promotion pathways.
- Research solutions to institutional policy and fiscal issues.
- Address major gaps in the dissemination and extension of existing knowledge and research findings; ensure that appropriate and effective uptake pathways are incorporated into any research initiatives; include training and support of extension services.

Notes

[1] A paper presented at the FAO / IBSRAM International Workshop: "Urban and peri-urban agriculture: closing the nutrient cycle for urban food security and environmental protection", Accra, 2-6 August, 1999

(http://www.cityfarmer.org/africaworkshop.html)

[2] Nsiah-Gyabaah (2000) reported it to be 1,500 mm but this may have been a "guesstimate". A 55 year mean figure of 1488 mm is given for Kumasi Airport

in CEDAR (1999, p.11). There seems to be some doubt, possibly arising from location of meteorological stations.

[3] Results are being entered into KUMINFO but were not available at the time of the review. They will complement the data entered as a result of a consultancy by Gibbs Ltd (consultants) in 1999.

[4] Exchange rate February 2000: £1.00 = Rs 68.00.

[7] Reduced fertility and shorter fallows were reported in $^1/_3$ of villages studied

[8] Based on a report presented at the FAO / IBSRAM International Workshop: "Urban and peri-urban agriculture: closing the nutrient cycle for urban food security and environmental protection", Accra, 2-6 August, 1999

(http://www.cityfarmer.org/africaworkshop.html)

[8] Based on a report presented at the FAO / IBSRAM International Workshop: "Urban and peri-urban agriculture: closing the nutrient cycle for urban food security and environmental protection", Accra, 2-6 August, 1999

(http://www.cityfarmer.org/africaworkshop.html)

[9] This was requested but never implemented

[10] Much of the data presented in this workshop were presented as tables with no or little interpretation.

[11] The Electrical Conductivity (in dS/m) should be approximately equal to the total dissolved solids [in ppm] x 1.5 /1000 but the actual EC was lower than this. This raises some doubts about the reliability of the analyses.

[12] http://www .cityfarrner.org/africaworkshop.html

6   The livelihood strategies of poor households in the peri-urban interfaces of Hubli-Dharwad and Kumasi

Poverty and the peri-urban interface

There has been little explicit work to date on the impact of peri-urban processes on household livelihood strategies. DFID's NRSP commissioned a study on poverty and the peri-urban interface (Rakodi, 1999) to guide research in poverty-focused peri-urban natural resource management. The conclusions arising from the study were as follows:

- There is very little available information that looks specifically at poverty in peri-urban areas.

- A process of increased differentiation or polarisation between capitalist and subsistence producers is often referred to in peri-urban areas.

- Those who cannot take advantage of the opportunities presented by urban markets include the already land poor, those who have insufficient capital to purchase land and/or intensify production, and those who are excluded from credit and extension systems. Often, women find it more difficult than men to access all these resources.

- Urban pressures on common pool resources such as forests, rivers and wetlands, may lead to environmental degradation and reduced access by the poor to products they were previously able to gather.

- Residents in villages within the zone of peri-urban influence are presented with alternative economic opportunities in the expanding urban economy. This might result from agricultural intensification, demand for raw materials, wage employment in urban enterprises or opportunities for self-employment.

- There is very little information available on processes of social change in peri-urban villages.

- There is likely to be increasing competition for resources (such as water, building materials, energy) between local communities within the peri-urban area and the city. Analyses of the relative access to infrastructure of rich and poor households are scarce.

Building on these conclusions, Rakodi (1999, p.58) puts forward a number of hypotheses:

In the early stages of urban influence and/or the outer parts of the peri-urban interface the opportunities for farm enterprises exceed the threats. Those who benefit tend to be the larger farmers, while those who are least able to take advantage of the opportunities are smaller farmers who lack capital and surplus land, leading to increased differentiation. Increasing access by small farmers to capital and other farm inputs would enable them to increase productivity and benefit from increased sale of surplus produce.

In the later stages of urban influence on the urban fringe areas or the outskirts of the built up area, the threats to farm enterprises outweigh the opportunities, leading to increasing abandonment of farming. Those who benefit from this process are those who can either sell land to speculators or developers or have the capacity to develop it. Those who lose tend to have little or no land, are dependent on wage or casual labour in other farms for all or part of their incomes, and are unable to take advantage of alternative economic opportunities in the urban labour market, because households and their members lack labour power, skills, contacts, capital, or freedom of movement. Those who have insecure rights to land, or who have little to sell, and who are excluded from urban labour market opportunities may be impoverished and, in any case, differentiation is likely to increase. Women are likely to be disproportionately affected.

Farmland may be converted from subsistence food production to either commercial production for the urban market or urban development. If the food producers are unable to access alternative income generating activities, households will suffer from increased food insecurity, which will be associated with increased malnutrition and poorer health status.

Those seeking new economic opportunities are likely to face barriers to entry erected by those already pursuing particular income generating activities. As a result, those who are forced to abandon cultivation and related activities on their own land will become more reliant on casual work or the less lucrative

informal sector trading and service occupations, and unemployment rates will increase.

These hypotheses could be used to feed into future research projects. The focus should, however, be on how natural resource-related peri-urban processes impact upon poor households, who may reside in city centres as much as in villages on the outskirts of Any work that aims to improve the livelihoods of poor people through sustainably enhanced production and productivity or renewable natural resource systems must have a good understanding of the livelihood strategies of poor households. Knowing who the poor are and how poor households respond to changes in natural resource production systems resulting from urban development is critical to the design of effectively targeted research and development activities.

The sustainable livelihoods framework

The concept of livelihood strategies builds on the now widely accepted broad interpretation of poverty. That is, that poverty is viewed as including a lack of basic needs, income/consumption, assets (material and non-material), dignity/autonomy, social inclusion, equality (gender and ethnicity) and political freedom/security (Carney, 1999). Broad interpretations of poverty facilitate analysis of the many causes and manifestations of poverty, leading to more creative and effective solutions.

A widely accepted definition of a livelihood provided by Chambers and Conway is given in Carney (1999, p.4), as:

> a livelihood comprises the capabilities, assets (including both material and social resources) and activities required for a means of living. A livelihood is sustainable when it can cope with and recover from stresses and shocks and maintain or enhance its capabilities and assets both now and in the future, while not undermining the natural resource base.

Singh and Gilman (1999, p.540) suggest that "livelihood systems consist of a complex and diverse set of economic, social, and physical strategies. These are realised through the activities, assets and entitlements by which individuals make a living". Building on the understanding of livelihood systems and strategies, Chambers and Conway, and Singh and Gilman go on to define what is understood by *sustainable livelihoods*. Singh and Gilman (1999, p.540) define sustainable livelihoods as those "derived from people's capacities to exercise choice, access opportunities and resources, and use them in ways that do not foreclose options for others to make their living, either now, or in the future". The definition of sustainable livelihoods has led to the development of approaches to analyse livelihood strategies and to develop ways forward to enable them to become more sustainable.

A sustainable livelihood framework has been developed by DFID in order to improve development activity through systematic – but manageable – analysis of poverty and its causes; taking a wider and better informed view of the opportunities for development activity, their impact and 'fit' with livelihood priorities; and placing people and the priorities they define firmly at the centre of analysis and objective-setting (Ashley and Carney, 1999, p.6). The approach has been defined by Ashley and Carney (1999) as a way of thinking about the objectives, scope and priorities for development, in order to enhance progress in poverty elimination.

Using the sustainable livelihoods framework enables a more holistic approach to be taken to development activity, recognising that people have a range of strategies on which they base their livelihoods. The framework is shown in Figure 6.1 and can be used as an analytical tool, or checklist, to identify issues that should be explored. A core feature of the framework is an analysis of the five different types of assets upon which individuals draw to build their livelihoods. These are natural, social, human, physical and financial capitals, described by Carney (1998b).

Part of the sustainable livelihoods' framework involves the analysis of *coping* and *adaptive* strategies. Coping strategies have been defined as "often a short-term response to a specific shock such as drought", and adaptive strategies
-term change in behaviour patterns as a result of a shock or stress" (Singh and Gilman, 1999, p.541). Adaptive strategies may be most relevant to understanding a peri-urban setting, as people and households change their strategies to make the most of, or to cope with, changes brought about by urban development.

Sustainable livelihoods and natural resources

The use of livelihoods as an analytical framework reflects recognition that "nowadays farming on its own rarely provides a sufficient means of survival in rural areas of low income countries" (Ellis, 1998, p.53). Ellis refers to *livelihood diversification*, involving wage work in agricultural and non-agricultural activities, non-farm self-employment (e.g. trading) and remittances from urban

areas and from abroad. Whilst Ellis is referring to the sustainable *rural* livelihoods framework, livelihood diversification remains a relevant concept in other locations. In peri-urban and urban areas, for example, households may let their rural land to others or obtain agricultural produce from land owned by the family in rural areas. Diversification of livelihoods can be both positive and negative: positive if diversification makes livelihoods more secure and reduces adverse impacts of seasonality, but negative if diversification results in lower agricultural productivity, for example. Ellis suggests that adopting a livelihood diversification perspective provides a framework for natural resource policies. This is because NR policy is fundamentally about improving the productivity of resources in agriculture, including livestock. But it is also about people's interactions with off-farm environmental resources for livelihood purposes, and it seeks to secure sustainable natural resource use in this respect (Ellis, 1998, p.62).

Ellis (1998, p.62) goes on to suggest that whilst livelihoods may be diverse, in rural areas, reliance on agriculture as the main source of income or food remains. He does suggest, however, that the "past neglect of livelihood considerations has sometimes resulted in natural resource policies and projects that have been insensitive to local priorities, mistaken in their assumptions about the availability of time and misdirected towards the better-off in rural communities rather than the rural poor". This is particularly true in peri-urban areas, where many other income-earning opportunities, such as urban casual labour (construction work or selling fruit and vegetables, for example) exist. These opportunities may provide poor farmers or landless labourers with more attractive work than agricultural activities.

Livelihood strategies in the peri-urban interface

The framework was initially designed to generate more understanding of rural households, but is now seen as a generic framework, for use in urban as well as rural areas (Singh and Gilman, 1999).[1] There are limited examples of its use in a peri-urban setting. Tacoli (1998) examines rural-urban interactions and the sustainable rural livelihoods framework, noting that the livelihoods of households in any location often include both rural and urban elements. She suggests that rural-urban interactions can be divided into two categories: linkages across space (such as flows of people, goods, money, information and wastes) and 'sectoral interactions' Sectoral interactions include 'rural' activities taking place in urban areas (such as urban agriculture) or activities classified as 'urban' (such as manufacturing and services) taking place in rural areas (Tacoli, 1998, p.67).

In a later paper, Tacoli (1999) reviews the contribution of a number of livelihood frameworks to understanding the opportunities and constraints for low-income groups. She suggests that "understanding transforming structures is especially important in the PUI, where institutional fragmentation and rapid change in the roles, responsibilities, rights and relations between different groups and organisations can result in growing social polarisation" (ibid, p.3). She also confirms the belief that "in the PUI, income diversification is likely to be intensified as the proximity of urban and rural labour markets can provide increased employment opportunities" (ibid, p.6).

Using the sustainable livelihoods' framework in a peri-urban context raises a number of specific questions, particularly regarding who and where are the households affected by peri-urban processes? The peri-urban interface has been characterised as intense flows of goods, people and produce between rural and urban areas, and people affected by such interactions could be located in urban centres or in rural areas as well as in urban peripheries. This makes the identification of beneficiaries more complex.

Whose livelihood strategies?

There is, therefore, a dilemma posed by the peri-urban interface regarding who and where are the potential beneficiaries of the peri-urban interface research programme. There is also the question of household or individual livelihood strategies. Although there is a significant literature stressing *intra-household* dynamics, it is widely accepted that households should be used as the unit of analysis within the sustainable livelihoods framework. The United Nations Framework for the Inter-Agency Task Force (IATF) on Employment and Sustainable Livelihoods, for example, uses households as the socio-economic/ecological unit (Singh and Gilman, 1999, p.543).

The sustainable livelihoods' framework has also been used to undertake a r people and different poor groups (Ashley and Carney, 1999). Carney (1998b, p.8) suggests that "the overall analysis of capital assets is most likely to be conducted for different social groups".

Preston (1994, p.203) argues that "a household focus permits a better understanding of how and why people organize their activities". Building on this, he argues that the concept of household livelihood strategies provides "a clearer view of both collective and individual processes of decision-making within domestic units". Preston uses the definition of households as "those living and eating together", which excludes family members who live elsewhere.

Source: Adapted from Carney (1999a)
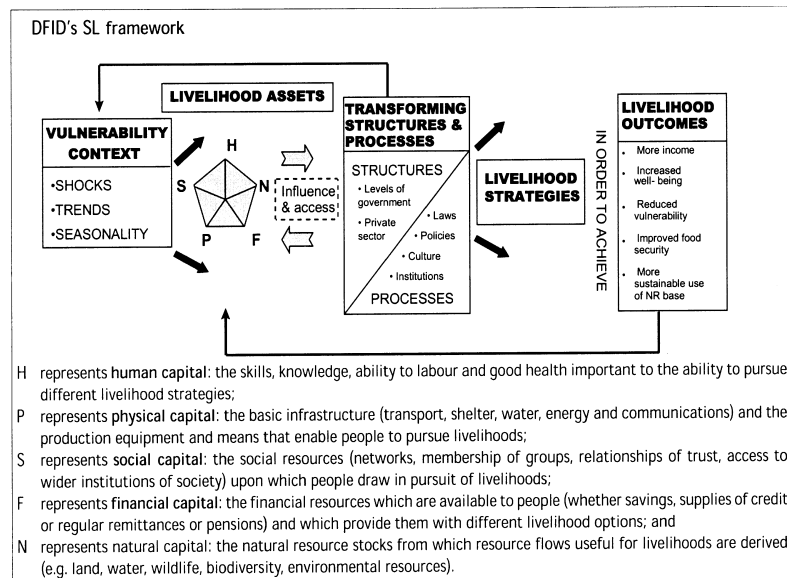
There are, therefore, a number of units of analysis that could be considered: individuals, households, families and different groups of poor people (e.g. women, elderly, landless labourers).

Using the sustainable livelihoods framework in the peri-urban interface

From this brief review of work on poverty in peri-urban areas, and of the use of the sustainable livelihoods' framework, the following conclusions can be made:

- The poor are more likely to be casual workers, and may move from working in agricultural work to more urban based work, such as construction, road building, selling fruit and vegetables. There may, however, be more opportunities for more casual agricultural work if agricultural intensification takes place. Such opportunities would be balanced by increasing mechanisation.

- Women may have greater opportunities for undertaking paid agricultural work, as more men take up urban employment. Wages may, however, remain low. Although there may be benefits in terms of increasing household income with women taking on more paid employment, there may also be adverse impacts on their work burden, child care and health.

- People respond differently to opportunities and threats posed by urbanisation. This could result in increasing polarisation between income groups.

- Diversifying income sources away from agriculture could lead to a decrease in agricultural productivity, which could have a long-term impact on the food security of poor households.

Before setting out the questions asked of the research undertaken to date in Hubli-Dharwad and Kumasi, it is useful to note other sources of guidance for undertaking livelihood analysis. Carney (1999, p.8), for example, suggests that in planning development activities, the use of the sustainable livelihoods' framework entails analysis of the context in which (different groups of) people live, including the effects upon them of external trends (economic, technological, population growth, etc.), shocks (whether natural or manmade) and seasonality. People's access to different types of assets (physical, human, financial, natural and social) and their ability to put these to productive use. The institutions, policies and organisations which shape their livelihoods. And, finally, the different strategies that they adopt in pursuit of their goals.

In reviewing the work undertaken by the NRSP's PUI research to date, it should be remembered that only since the development of the revised logical framework (December 1998) has a strong and explicit poverty focus been present. Although information has been generated on livelihood strategies in Hubli-Dharwad and Kumasi, no explicit livelihood analysis has been undertaken. It is, therefore, useful to use the sustainable livelihoods' framework to review the documents by seeking the following information:

- Who are the poor? Is there information on the types of indicators that might enable targeting of poor people?

- The poor may be defined in terms of households, individuals or different poor groups. Whilst parts of the logical framework talk of the livelihood strategies of poor households, there may be more information on different groups of people. Any analysis of household livelihood strategies also needs:

to be aware of household dynamics and the role of wider family ties that may form part of household or individual livelihood strategies. Where are the poor? This point is related to the first, but reflects the peri-urban nature of the research. Which poor households are affected by peri-urban processes?

- What types of capital assets do poor people have?

- What does the peri-urban context contribute in terms of increasing/decreasing vulnerability? What constraints and opportunities exist?

- Are there examples of adaptive strategies in response to urban development?

- What structures and processes exist to transform livelihood strategies?

- What gaps exist in terms of understanding livelihood strategies and understanding responses to peri-urban processes?

- How can livelihood strategies be strengthened/made more sustainable through natural resource research and development?

Livelihoods in the peri-urban interface of Hubli-Dharwad

Poverty in India

A recent analysis of DFID's contribution to poverty reduction in India (Shepherd *et al*., 1999, p.7) reached a number of important conclusions. Among these were the fact that most of the poor are casual workers, particularly rural workers, both agricultural and non-agricultural and that wage rates are a prime determinant of poverty. Within the poor, female-headed households, and households with large numbers of children, were especially vulnerable. Scheduled tribes are the most economically destitute within the rural population. And in terms of both extent and severity, scheduled tribes and castes together are significantly more affected by poverty than the population as a whole.

The study also found linkages between income poverty reduction and the initial level of female labour force participation. It concluded that where women are part of the labour force, poor households have more working members, may be less vulnerable to shocks and may be able to take more risks and make investments. It also found that men may be freer to migrate for employment, an important strategy for poor households especially in the remoter areas. Finally, it concluded that women, and therefore girl children, may be more highly valued.

While these observations present positive impacts from women entering paid labour, there are implications for their health and childcare, which may both suffer due to extreme work burdens. Women are often paid the lowest wages for the most backbreaking work. These brief conclusions can be used to guide analysis of the situation in the Hubli-Dharwad city-region and to assist in identifying poor households and poverty trends in the city-region.

Who and where are the poor in the Hubli-Dharwad city region?

There is little explicit information on the level of poverty in the Hubli-Dharwad city-region. Work undertaken in the NRSP Peri-urban Interface programme, however, has identified a number of indicators that could be used to identify poor households. These include:

- Occupations of household members and how many household members have paid employment. Members of poor households are more likely to work as casual labourers. Women working outside the family may be an indicator of a poor household.

- Income levels, either as a day rate (e.g. women receive between Rs.20-25 a day in agricultural work), or income from farming. Such information may be provided by village accountants.

- Land holdings. Poor households will have either very little land or no land at all. Information on land holdings in villages and on crop yields can be provided by village accountants in villages outside the Hubli-Dharwad Municipal Corporation boundary.

- Access to common property resources is often critical to poor households, particularly if they own livestock.

- Family size and level of education. These factors can indicate levels of deprivation (e.g. large family, few household members in paid employment and low levels of education).

- Ownership of a green card to access food at low prices, which have been distributed in the last few years to low-income households in rural areas. Criteria assessed include income, land holding and other livelihood activities carried out by the household.

The indicators set out above could be used to explore the extent and characteristics of poverty in the city-region. Other indicators of where poor

households may live include the existence of slum areas within the urban boundary.

A study of urban agriculture in Hubli-Dharwad looked at the existence of slum areas within the city as an indicator of where the poor lived. In 1981, there were 52 notified slums in the city and slum dwellers represented 8.68% of the total population. Recent figures taken from 1998/99 indicate that the number of slum areas has slightly decreased, with 31 identified and registered slums in Dharwad and 15 in Hubli (Nunan, 1999). The number of people living in slum areas has, however, increased by 17.55% to 16,738. This is slightly less than the population growth rate between 1981 and 1991. The slum population does not account for all households living below the poverty line. Indeed, it has been suggested that more than 40% of the urban poor do not live in slum areas in India (Shepherd *et al.*, 1999). There are, at present, no other indicators of the location of poor households within Hubli-Dharwad. However, research does indicate, that, in India, the urban poor are characterised as having casual employment or self-employment in the informal sector, and that poverty amongst female headed households is more serious within urban areas than rural (Shepherd *et al.*, 1999.).

Scheduled castes and tribes are often prevalent amongst the poor in India. The Baseline Study (University of Birmingham *et al.*, 1998b) analysed data in five taluks closest to Hubli-Dharwad in a range of areas. Data on the numbers of scheduled tribes and castes was collected for the five taluks, taken from census data. It was found that only 61,077 (8.6%) of the population in the five taluks were members of scheduled castes according to the 1991 census. Only 23 villages, 6.5% of the villages in these taluks, had over 20% of their population classified as scheduled castes and 12,789 (1.8%) of the population in the five taluks were classified as scheduled tribes. Some villages, however, have higher concentrations of scheduled castes and tribes than others.

Finally, small farmers are more likely to be poorer than farmers owning more land. This is not always the case, however, as farmers may rent land from other landowners or may be involved in substantial income generating activities outside of agriculture. There has not been enough information gathered to date to know the extent of poverty amongst small farmers in the Hubli-Dharwad city-region. In the Baseline Study, however, it was found that small farmers tend to be found in larger numbers in wetter red soil areas (to the south and west of Hubli-Dharwad), whilst large landowners tend to be concentrated in the drier east, where dryland farming takes place on black cotton soil (University of Birmingham *et al.*, 1998b).

Analysis of asset status

Most information about the capital assets of poor households or groups has been collected in the area of income generating activities. These are discussed in the section on financial assets and a number of household case studies illustrate the diversity of income sources that some households rely on, partly in response to urbanisation.

Natural capital

Information has been collected on land use, water resources and forest cover. There is little information, however, on entitlement issues, that is the level of access to, and control of, natural resources. The Census does not provide information on who owns lands, including absentee landlordism with rented plots or share cropping (University of Birmingham *et al.,* 1998a, p.23). However, the village surveys obtained some information. Village informants quantified landowners in various categories for 1987 and 1997 (ibid, p.33). Land records exist which provide information on each plot of land within a village, but they are in several forms and in several places (ibid, p.116). Land is traded, but village surveys provide only general impressions of what types of purchasers are buying land, whether it is farmers for other villages or urban dwellers buying land for investment or speculative purposes. Little information exists on who is involved in land transactions. Government actors in land planning and other land management activities are obviously known locally, yet they seem to be largely ineffective and may not figure as important stakeholders (ibid, p.106-118). It was found in the Baseline Study (c.f. R6825) that in many villages land has only been sold to local people. The operation of the land market is poorly understood, yet this is a vital component of natural capital. It is not known what are the livelihood strategies of previous land owners who have sold this asset.

There has been little discussion of access issues. Land is passed down through generations and divided between sons. In some villages, it has been noted that some poorer farmers are farming more marginal land, but not enough information has been collected to date on the type and amount of land farmed by small, poor, farmers.

The amount of land used for agriculture and other purposes was provided in the Baseline Study report for the five taluks, but no information is given on access to land. The indicators all illustrate a decline in the availability of land per cultivator within the five taluks. Land pressures appear to be greatest in Hubli and Dharwad taluks, though it is not clear whether this is due to out-migration of households in the other three taluks studied, or because of in-migration into Hubli and Dharwad (University of Birmingham *et al*., 1998b, p.181) However, eight villages further from the city limits were found to have greater land pressures, suggesting that more complex factors are at work causing land pressures and land shortages than in-migration and proximity to the municipal boundaries (University of Birmingham *et al*., 1998b, p.182)

Only a small proportion of land is defined as culturable wasteland[2], which includes common land. Some of the villages studied showed a decline in the amount of common land, whilst others, particularly villages in the three taluks close to the city, appeared to have more common land available in 1997 than 1987. University of Birmingham *et al*., (1998b, p.22) speculated that this could be due to the abandonment of farm land near to the city, but this has not been confirmed. The availability of common land has an impact on the ability of the landless, and possibly small farmers, to keep livestock. Where the amount of common land is decreasing, animals are likely to be grazed on crop residues. Nidagundi and Patil (1999, p.6) note that the Gram Panchayat (village council) is able to charge a fee for grazing cattle in the grazing lands. They also record that

> the right to grazing or collect other produce of all unoccupied land vesting in Government, whether such lands are surveyed, settled and assessed or not and of lands specially reserved for grass or for razing (except lands assigned to villages for free pasturage), may be sold by public auction every year, either field by field or in tracts, and at such time as the Deputy Commissioner shall determine (Nidagundi and Patil, 1999, p.26).

However, more information ought to be collected on how such regulations impact in practice on the access of livestock keepers to grazing land.

Details on the area of forested land are given in University of Birmingham *et al*. (1998b, p.183) and there is some discussion of issues surrounding access to the forest areas. In some of the villages studied, villagers access the nearby forests for fuelwood and for leaves to make leaf plates. Although it does appear that there is less fuelwood available than ten years ago, people have not expressed concern over shortages in any of the studies undertaken (University of Birmingham *et al*., 1998b, Wilkinson, 1999).

Finally, water resources have been studied in terms of water supplied to the city and access to borewells. It has also been reported that many tanks in the urban area have dried out and built over. There is concern about the effects on the micro-climate and hydrology, though this has not been researched. Low-income households in villages around Hubli-Dharwad use tanks for laundry and washing buffaloes and cattle. Issues of management of, and access to, tanks around the city region have not been studied in-depth.

Human capital

Human capital encompasses areas such as literacy, skills, good health and the ability to labour. Information on literacy levels was collected during the Baseline Study for five taluks around the city-region. The 1991 Census of India definition of literate was someone who can both read and write with understanding in any language. 42.17% of the rural population in the five taluks were considered literate in the 1991 census. The male literacy rate of 54.1% is very much higher than the female literacy level of 29.5%, but literacy levels vary between villages. The Baseline Study (University of Birmingham *et al*., 1998b, p.169) speculated that the two easterly taluks (Navalgund and Kundgol) have better agricultural yields and may be in a better position to send children to school, accounting for higher literacy levels. Lower literacy levels close to the city could be accounted for by migration into the city by more literate people. Whatever explanations there may be, the differences between male and female literacy are significant and have implications for livelihood options for households.

Although the census data are not broken down by any other indicators, such as income level, literacy levels can be used as one indicator to identify areas or villages that may have higher incidences of poverty.

Access to health facilities has not been explored in the Hubli-Dharwad city-region, though health risks associated with the use of untreated waste have been explored in some projects. The health impacts of using untreated waste include the use of untreated sewage for irrigating and washing vegetables and the use of untreated and semi-sorted municipal solid waste as a soil amendment, though hospital waste is now being collected separately from municipal waste. A small study was undertaken in 1997 to explore the health impacts of irrigating with

untreated wastewater on agricultural labourers. The results were not significant, though did indicate that skin diseases may be a particular problem associated with the use of untreated wastewater. As members of poorer households are more likely than others to work as agricultural labourers, they will be more exposed to such health risks. Birley and Lock (1999, p.11) suggest that an understanding of the health impacts of natural resource projects is critical if projects are to be sustainable and livelihoods improved.

Social capital

Little information has been collected to date on the role of social capital in livelihood strategies through the NRSP studies. Reference has been made, though, to the role of extended families, with many members of a family often living in one house. The extended family does play an important role in providing opportunities and contacts in India. The caste system also remains important to some extent. Some of the villages studied have specific areas where members of low castes live. It is not clear, however, how the caste of a person affects their opportunities in responding to urbanisation. However, it does appear from other studies in India that members of scheduled castes and tribes are found in larger numbers in proportion to the population in poverty.

A four-village study undertaken by Nidagundi and Patil (1999) recorded that there are good social networks in some villages comprising of groups such as self-help groups, including farmers' organisations providing loans (Vyayasaya Seva Sahayaka Sangha); women's associations, e.g. Mahila Mandal, Raita Mahila Seva Sangha (an association set up by the India Development Service in Mugad village) which encourage women to save money; a dairy Co-operative Society; occupational associations, for example a Potters' Association and Fishermen's Association, which help to markets products and produce; religious groups organising festivals, ceremonies, etc.; and political involvement through the Gram Panchayat.

There is little discussion in the report, however, about the role of such networks and groups in the lives of poor households.

Physical capital

Some information on physical capital has been collected to date. The importance of access to infrastructure, particularly roads, has been noted in helping people take advantage of living relatively close to a city. Roads help to get goods to market and enable people to take up work opportunities, particularly where there are bus services to a village, especially casual work, in the city.

An area of physical capital that has been more extensively researched has been energy sources. The Baseline Study undertook several pieces of work to explore energy issues and this was followed up by a review of energy issues led by ITC (Wilkinson, 1999).

Some of the main findings from surveys in the Baseline Study include:

- Agricultural waste (e.g. cotton and chilli stalks) is the main source of fuel for cooking and heating water in rural areas.

- Landless and some occupational groups spend two to four hours a day gathering agricultural waste from farmers' fields, village streams and forest areas.

- Electricity and kerosene is used for lighting in both rural and urban areas, with poorer households more likely to use kerosene than other households, though some poor households do have electricity.

- Households in the urban slum areas mainly use firewood, twigs and branches for cooking and heating water.

ITC found that all six of their case study villages have biogas plants (Wilkinson, 1999). A key determinant of continuing to use biogas is the availability of cow dung. In some areas, the cattle population is declining, partly due to the declining availability of common grazing land.

In landless and small farm households, firewood makes up the highest proportion of total energy consumed for domestic purposes. Landless households use a slightly higher proportion of cow dung cakes than other income groups. It was found that traditional fuel sources remain and there have been no substantial changes in the types of fuels used in villages (Wilkinson, 1999). Dung cakes remain popular with the poor as they are free to produce, though take time. Women from non-cattle owning households (often the poorest) collect dung from the roadside or grazing land when returning from working in the fields and make them into cakes (ibid, p. 4.12).

The ITC study also explored preferences for different types of fuels. Ranking exercises showed that there is a clear preference for modern fuels for cooking in all social categories. However, landless labourers were the only ones

to rank kerosene above LPG and biogas. This ranking may be due to the fact that it is more affordable than other modern fuels and can be purchased in small

quantities. All categories of respondent ranked traditional fuels as best for heating water. Finally, all villages surveyed preferred electricity to kerosene for lighting. In the women only group meetings, preferences were divided by age groups (though the groups did not differentiate by social group). Younger women preferred modern fuels, whilst their mothers and grandmothers preferred traditional fuels (Wilkinson, 1999, p. 4.8).

The frequency of collection of fuelwood differs according to income group, with wealthier households using tractors and trailers or bullock carts to collect fuelwood only a few times a year. Labourers are sometimes employed to do this. Landless labourers collect fuelwood either daily or weekly, depending on storage space, taking between four and ten hours a week. It was felt that over the last ten years, the distance needed to collect fuelwood has increased and it takes 50% longer.

Some poor households gain access to cotton stalks to use as fuelwood by exchanging labour for cotton stalks. These crop residues are stored outside and will rot in the rains, and so, large farmers may not be able to consume all the stalks, providing an opportunity for exchange and an alternative to firewood. Wilkinson (Wilkinson, 1999, p. 4.12) notes, however, that information was not collected on whether women collect crop residues and whether there are gender implications resulting from the increasing use of crop residues as a fuel.

Financial capital

Most information collected to date has been on income generating activities. Very little information has been collected on access to credit by small farmers, though some of the farmers studied in the waste research have borrowed money from moneylenders and banks, whilst one was a moneylender himself (University of Birmingham *et al.*, 1999a). No information has been collected on remittances either from the urban area to rural areas, or to Hubli-Dharwad from family members in other cities or countries. Source of credit for small, poor, farmers or livestock keepers may be an area needing further investigation.

Information on employment and income generating activities has largely been taken from census data, though there are case studies of individuals that illustrate the diversity of income sources that exist in some households (see Box 6.1).

The Indian Census defines workers as those who participated in any economically productive activity for at least 183 days during the preceding year,

and marginal workers as those who worked less than 183 days. It has been noted that many poor households rely on agricultural labour as their main source of income and data on the numbers involved in agricultural activities in the Hubli-Dharwad city region have been explored. The figures for males and females working in agriculture in the rural areas of Dharwad District[3] and Karnataka State are given in Tables 6.1 and 6.2. In the census, agricultural activities were categorised as cultivation, agricultural labourer and livestock farmer. There is no information in the census data on income groups within the agricultural sector, though it is likely that most, if not all, agricultural labourers are lower income people, and, as seen by the figures in Tables 6.2 and 6.4, many of these are women.

Tables 6.1 and 6.2 show the dependence on agriculture in the rural areas of the District and the State. Within Dharwad District, the proportion of women working as agricultural labourers, as opposed to being cultivators or livestock keepers, is particularly striking.

Table 6.1   **Share of the rural male workforce relying on agricultural activities in Karnataka State and Dharwad District, 1981-1991 (%)**

Activity	1981		1991		Change (%)	
	Karnataka	Dharwad District	Karnataka	Dharwad District	Karnataka	Dharwad District
Cultivation	55.3	47.7	50.6	45.2	-8.5	-5.2
Agricultural Labourer	23.6	34.8	26.4	35.9	11.9	3.1
Livestock Farmer*	4.6	2.2	4.6	1.9	-0.9	-16.1
Total agricultural activity	83.6	84.73	81.7	83.0	-2.3	-2.1

Source: Vyasulu (1997, p.17), with data taken from census results.

Table 6.2　　Share of the rural female workforce relying on agricultural activities in Karnataka State and Dharwad District, 1981-1991 (%)

Activity	1981		1991		Change (%)	
	Karnataka	Dharwad District	Karnataka	Dharwad District	Karnataka	Dharwad District
Cultivation	28.4	19.4	29.6	22.5	4.4	16.0
Agricultural Labourer	55.0	73.8	55.6	70.9	1.1	-4.0
Livestock Farmer*	4.0	0.4	3.3	0.3	-16.8	-11.1
Total agricultural activity	87.4	93.6	88.6	93.7	1.3	0.2

Source: Vyasulu (1997, p.17), with data taken from census results

Tables 6.3 and 6.4 give the figures for the share of people working in agricultural activities in urban areas. In Hubli-Dharwad city this share declined from around 13.7% in 1981 to 12.4% in 1991. Hubli-Dharwad is by far the largest urban centre in Dharwad District and is the third largest urban agglomeration in the State of Karnataka. This may account for the lower figures involved in urban agricultural activities, with greater opportunities for casual and permanent non-agricultural employment.

The share of the urban female workforce relying on agricultural activities in all the urban areas of Karnataka is much higher than that of the male workforce thus suggesting that agricultural activities are very important as a source of income for women. The highest percentage is for agricultural labour. Although there has been a decrease in Hubli-Dharwad, agricultural activities remain a significant employment opportunity for the urban female workforce.

This is consistent with the findings of village surveys within the Baseline Study (c.f.R6825), which found that female occupation within casual farm work has increased relative to male employment in five taluka close to the city. Male employment in casual farm labour decreased due to more males taking up urban-based casual employment, particularly construction work (University of Birmingham *et al*., 1998b). In the Baseline Study, in 22 of the 25 villages surveyed, it was found that most labourers were engaged in agricultural work. While there was an increase of 16.6% in the number of agricultural labourers between 1987 and 1997, however, there were much greater increases in the numbers of industrial (49%) and construction workers (153%) (University of Birmingham *et al*., 1998b, p.29).. In 1997, 15% of the agricultural labourers

Table 6.3　　Share of the urban male workforce relying on urban agricultural activities in Karnataka State, Dharwad District and Hubli-Dharwad city, 1981-1991 (%)

Activity	1981			1991			Change 1981-1991 (%)		
	Karnataka	Dharwad District	Hubli-Dharwad	Karnataka	Dharwad District	Hubli-Dharwad	Karnataka	Dharwad District	Hubli-Dharwad
Cultivation	7.5	12.0	6.0	6.1	10.5	5.5	-19.5	-12.2	-8.8
Agricultural labourer	6.0	12.4	5.4	5.8	11.6	4.3	-3.0	-6.3	-21.4
Livestock farmer*	1.8	1.6	--	1.9	1.6	1.2	3.9	-1.2	--
Total agricultural activity	15.4	26.0	11.5	13.8	23.8	10.9	-10.3	-8.7	-4.5

*Livestock farmer figure not available for 1981 in Hubli-Dharwad, so total agricultural activity figure is a slight underestimate.
Source: Vyasulu (1997, p.17), from data taken from census results for Karnataka State and Dharwad District. Figures for Hubli-Dharwad taken directly from census results.

Table 6.4　　Share of the urban female workforce relying on urban agricultural activities in Karnataka State, Dharwad District and Hubli-Dharwad city, 1981-1991 (%)

Activity	1981			1991			Change 1981-1991 (%)		
	Karnataka	Dharwad District	Hubli-Dharwad	Karnataka	Dharwad District	Hubli-Dharwad	Karnataka	Dharwad District	Hubli-Dharwad
Cultivation	5.4	7.1	4.8	5.2	9.5	5.0	-3.7	33.6	4.0
Agricultural labourer	21.3	43.4	21.5	18.5	38.7	14.4	-12.8	-10.9	-33.0
Livestock farmer*	1.3	0.9		1.3	0.5	0.7	-37.7	--	--
Total agricultural activity	27.9	51.4	26.2	25.0	48.7	20.0	-10.4	-5.1	-23.5

*Livestock farmer figure not available for 1981 in Hubli-Dharwad, so total agricultural activity figure is a slight underestimate.
Source: Vyasulu (1997, p.17), from data taken from census results for Karnataka State and Dharwad District. Figures for Hubli-Dharwad taken directly from census result

labourers worked outside the village. Travelling to work outside the home village increased over the decade.

Men working as agricultural labourers earn between Rs.20 to 50 a day, compared with Rs.20 to 30 a day for women. Wages differ according to the type of activity and those that women are involved with tend to attract a lower wage (Nunan, 1999, p.41). These activities are mainly weeding and harvesting.

The number of workers engaged in non-farm activities increased by 36.2% in the five taluka between 1981 and 1991. Male non-farm workers increased by 38.4% and female non-farm workers by 24.9%. Changes appear to be most pronounced near to the city. In Hubli taluk, for example, nearly 27% of villages (where there was information for both years), had an increase of over 100% in the number of non-farm workers over the decade (University of Birmingham *et al*., 1998b, p.177). In some villages, though, there was a reduction in the number of non-farm workers, perhaps suggesting that village enterprises were not able to compete with the city, or that non-farm workers were moving to the city.

The importance of agricultural work is again illustrated in Table 6.5, which summarises some of the findings from the survey of 25 villages in five taluka in the Baseline Study. The survey results revealed that many low-income groups work as agricultural labourers and that there has been a loss of common land in some villages, resulting from house building and industrial plants. In villages that are well connected to the city by roads and bus services, many landless labourers are increasingly taking on construction and road-building work. This has caused labour shortages in some areas, contributing to changes in cropping patterns and to recruiting labourers from villages further from the city.

The studies also reveal that landless labourers undertake seasonal work, such as construction work, at times of low demand for agricultural work and also undertake activities such as selling produce for farmers in the cities. These findings have been confirmed by further village studies conducted by Nidagundi and Patil (1999), though in some villages the shift away from agricultural labour was attributed to declining productivity resulting from increasingly erratic rainfall patterns.

Case studies of income sources

In a number of the projects undertaken, household case studies have generated information on livelihood strategies, particularly in relation to the diversity of income sources that people have. In a stuy on urban agriculture, for example, a number of households were interviewed to discover how important livestock keeping is for their livelihood. Some households in the city keep only two or three buffaloes, which contribute to their livelihood through selling milk and providing milk for the household. It does appear, however, that poorer households keeping buffaloes sell more of the milk produced and keep back less for home consumption than wealthier households (Nunan, 1999). The case study of Shankar Bendre's household in Dharwad city illustrates the role of buffalo keeping in a household livelihood strategy. Box 6.1 summarises the range of income sources for two other households, as illustrations of how living near to, or in, a city can help to generate a range of income sources.

Some agricultural households have responded to labour shortages by recruiting labour from villages further from the city, increasing the use of tractors and other mechanical implements and changing cropping patterns. There is not much evidence to date of many people abandoning agriculture because of the declining availability of labour.

The peri-urban features of the city region identified in University of Birmingham *et al.* (1998b, p.10). may assist in understanding how households have responded to changes brought about by urbanisation. The report concludes that there is uneven development between villages; explanatory factors include soil type (red and black); accessibility (roads and bus services); availability of irrigation facilities. Social differences appear to widen as villages experience greater influence from the urban areas. It also concludes that there is high degree of 'rurality': rural activities are important to some urban residents (e.g. urban dairies, owning rural land to grown own produce); big industry some distance from the city. Finally, it becomes clear that there is a dearth of information about the 'peri-urban interface'.

These features make identifying poor households and understanding their livelihood strategies a complex process, as they are located in different villages and parts of the city and respond to urbanisation differently.

The conclusions identified by Rakodi (1999) imply that some households may become more vulnerable in terms of poverty as an urban area expands than others. Little evidence of increasing polarisation has been collected in the Hubli-Dharwad city-region, though it has not been actively sought to date. There is, however, some grazing.

The vulnerability context in the peri-urban interface of Hubli-Dharwad

Urbanisation can be expected to bring about changes in the livelihood strategies of households in villages close to the urban area. This has been found in Hubli-Dharwad, though most evidence of responding to urbanisation to date points to landless labourers taking advantage of casual employment to either replace agricultural work altogether or to provide work when demand for agricultural work is low. Urbanisation, in this situation, helps landless households cope with the seasonality of demand for agricultural work. It has been noted that the increase in non-farm employment has been particularly marked for men (University of Birmingham *et al.,* 1998b, p.18). Given that female non-farm work increased much more slowly than male, most women were finding work in the lower paid farm sector, though women are paid less than men in the agricultural sector. There have, therefore, been changes in the labour markets, but there has been no evidence of wages for agricultural work rising significantly to attract labour.

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The conclusions identified by Rakodi (1999) imply that some households may become more vulnerable in terms of poverty as an urban area expands than others. Little evidence of increasing polarisation has been collected in the Hubli-Dharwad city-region, though it has not been actively sought to date. There is, however, some evidence of increasing pressure on common property resources, particularly grazing land and tanks, which could increase the vulnerability of poor households by reducing their ability to keep livestock. There is also evidence of increasing competition for some resources between urban, peri-urban and rural areas, particularly in the areas of electricity and water. These resources are not supplied in adequate amounts to satisfy agricultural, industrial and/or domestic demands, and the inadequate supply is affecting development in the city region. Access to irrigation facilities has been observed to be an important factor in increasing agricultural productivity of dryland farming, for example.

Transforming structures and processes in Hubli-Dharwad

There are several areas in which information has been collected on structures and processes that affect household livelihood strategies. These include access to markets for agricultural produce, the effects of incorporating villages into the Hubli-Dharwad Municipal Corporation boundary and land-use planning processes. Inadequacies in the marketing of produce in local markets were noted in the Baseline Study report. The marketing of horticultural produce is broadly the same for produce grown close to the city and further away. Though small farmers living close to the city have easy access to markets, farmers with access to a bus route into the city can still bring produce in relatively frequently. This is particularly important in Hubli-Dharwad because of the lack of cold storage facilities. Produce has to be sold quickly, and, therefore, frequently. Some farmers employ people (generally women) to sell fruit and vegetables on their behalf in the markets and alongside the main roads. This is on a casual, or informal, basis.

The Baseline Study report found, however, that local agricultural markets were fragmented, with "insufficient linkages to the state, national and international markets resulting in highly localised gluts, sporadic price collapse and price signal distortions" (University of Birmingham *et al.*, 1998b, p.50) These problems may deter farmers from taking risks, especially poorer farmers. Although there are organisations set up to assist in marketing, such as the Karnataka Horticultural Producer's Co-operative Marketing and Export Society, it is not clear how much such organisations benefit small, poor farmers.

As was noted in chapter 2, when villages are incorporated into the Hubli-Dharwad Municipal Corporation (HDMC) boundary they lose their village

council (Panchayat) and have to elect representatives to the Corporation. The village council, made up of members from the village, is closer to the village in terms of decision-making, while the HDMC seems more remote and less accessible. This change of power must have effects on people's ability to respond to urban influence. The incorporation into the HDMC boundary also means that people lose access to the State's Department of Agriculture and the associated agricultural assistants, meaning that farmers cannot easily access new information and cannot access subsidies and rural credit schemes. Again, there must be negative impacts for small, poor, farmers in particular. This area of concern has been identified in the research process, but has not been researched in depth.

As was discussed in chapter 2, land-use planning is undertaken by the Hubli-Dharwad Urban development Authority, whose boundary extends beyond that of the HDMC. Changing the use of land will impact on poor households, by losing agricultural land and/or by providing new opportunities for construction and industrial work. The land use planning process does not use an extensive system of consultation to obtain a wide range of views. Poorer households could lose out by losing access to common property resources and to agricultural work if they are not able to take advantage of urban work.

Sustainable livelihoods in peri-urban Hubli-Dharwad: Concluding comments

To conclude, the above review has noted information in the following areas:

- There is some information on indicators of poverty, but these could be further researched. Much information can be collected at village level, but area specific information is harder to obtain in the city.

- Landless labourers are identified as a poor group, but many are responding to opportunities presented by the urban area, using casual work to supplement or replace agricultural work.

- Some evidence of detrimental impacts on common property resources, resulting from privatisation. Impact on the livelihoods of poor households can be speculated, but have not been researched.

- There is a range of information available on the types of assets that households may access to sustain their livelihoods, but not all the

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Box 6.1 Case studies of household income sources in Hubli-Dharwad

Shankar Bedre, Dharwad city

Shankar's family comes from a tradition of keeping buffalo. They presently have two buffalo, both milking, producing 3-4 litres a day. Half a litre is kept for home consumption and the rest is sold to residential customers in the nearby locality. The husband milks the buffalo and the son delivers it to customers, in the morning and evening. Both the husband and wife have other sources of income. Shankar's husband works in a hotel and she takes on casual work, in the form of washing and cleaning, in big houses. She does this twice a day, leaving the children to look after themselves. The family gets around Rs.1300 a month from waged work and Rs.900 from buffalo. The family uses dung cakes for cooking and collects enough dung for around one tractor load. This is sold to farmers who come to the area looking for dung in May or June.

Jumma, Dharwad city

Jumma's family has 20 sheep at present, some of which are milking. There are nine people in the household and about half the household's income comes from keeping sheep (around Rs.100-200 per week). The sons undertake daily labour, mostly construction work, for Rs.50 per day and the daughter picks cotton. The women in the household look after the sheep. The family were traditionally gowlies, but had to sell their buffaloes, around 10-15 years ago, to raise money. They found it too expensive to keep buffalo, particularly buying fodder, and find it easier to graze sheep. They get Rs.600 per sheep for meat, which are sold when the family needs the money, in the local market, directly to consumers who then arrange the slaughter. The family occasionally keep milk from the sheep for home consumption, but never kill a sheep for home consumption. The family also keeps four layer hens. They collect around one tractor load of dung per year from the sheep, which they keep tied up at night, just next to their house. The dung is stored until there is enough to sell and is sold for Rs.200-300.
Source: Nuna (2000)

Bassappa Lakkalla Kumbar, Mugad

Bassappa Lakkalla Kumbar lives with his wife, son and daughter and has two acres of land in Mugad. In addition to growing rice for home consumption, the husband and wife are potters, and the husband works on other farms or in road preparation for three months, earning around Rs.40 a day. His wife works in their fields during peak labour-demanding periods. He hires one other labourer for sowing and between 10 and 12 for weeding and harvesting. Bassappa owns two bullocks and a cart and uses manure as a soil amendment.
Source: University of Birmingham *et al. (*1999a, p.36).

information can be disaggregated. It is not, therefore, always clear that poor households have access to the assets discussed in this paper, such as land and social networks.

It also appears from the review that not enough is known about the extent of poverty amongst small farmers. Whilst it is evident that agricultural labourers receive a low wage (compared to urban casual work), working with small farmer. Livestock may play an important role in the livelihood strategies of poor households, but this area could be further researched, particularly in relation to access to common property resources.

Gender aspects of changes brought about by urban development have been noted in terms of more women entering paid farm work and in the increasing time it takes to collect fuelwood. From the analysis of poverty in India quoted earlier (Shepherd *et al.*, 1999), it seems critical that gender dimensions of natural resource management are understood and built upon in peri-urban research.

Finally, little information has been collected on the role of migrants in peri-urban natural resource management in Hubli-Dharwad. One study on the valuation of peri-urban natural resources noted that fisherfolk come from Tamil Nadu to fish in Unkal tank during the four-month fishing season (Nunan *et al.*, 2000). Unkal tank is on the outskirts of Hubli and a contract for fishing is given to a contractor by HDMC each year. The extent of seasonal migration to and from Hubli-Dharwad has not been researched as part of this programme. There may be impacts from urbanisation on the livelihoods of migrants, both in terms of new opportunities (e.g. agricultural work) and in limiting opportunities (e.g. the tank could be cleaned up and used as a source of drinking water).

Livelihoods in the peri-urban interface of Kumasi

Poverty in Ghana

Poverty in Ghana has been defined as "a composite of personal and community life situations. On the personal level it is manifested by the inability of the individual or the household to acquire the basic necessities of life in terms of food, shelter and clothing. At the community level the absence to low level of basic community services such as health, education, water supply and sanitation, and in terms of incomes, subsisting on incomes that are less than two-thirds the national average" areas (Nsiah-Gyabaah, 1998, p. 2). It is also said that as a result of the high incidence of poverty in the rural areas and among the farming population, poverty in Ghana has largely been described as a rural problem. Consequently major poverty alleviation programmes have concentrated on the rural areas to the neglect of the peri-urban and urban poor. It is clear from recent studies that the incidence and depth of poverty is on the increase especially in peri-urban areas (ibid.).

For the purposes of characterising livelihoods in Kumasi's peri-urban interface, this review consulted a number of outputs from the Kumasi Natural Resource Management Research Project (KNRMP), as well as other studies. An important source of information was a Village Characterisation Study (VCS) conducted within the KNRMP with the aim of determining "the characteristics of peri-urban villages in terms of their natural resource management, community structures and relationships to Kumasi" (Blake *et al.*, 1997a, p.11). Sixty-six villages within a 40 km radius of the city centre were selected using a stratified random design. Another useful source of information was a separate survey of eight peri-urban villages as part of a wider study into urbanisation, land markets and gender insecurity funded by the Nairobi-based Mazingira Institute (Kasanga, 1998).

Who and where are the poor in the Kumasi city region?

Table 6.6 describes the main and supplementary occupations of the sample of 480 people in the eight peri-urban villages of the Mazingira study, the furthest of which is located about 25 km from the city (see chapter 2 for more information on Kumasi's peri-urban interface).

The continued importance of agriculture is evident, as 37% of the population have reported farming as their main occupation, but this is particularly so for women. Further data in Kasanga (1998, p.94) shows a clear influence of marital status; of the single people interviewed only 17% of the women and 33% of the men were still farming.

There is also a clear difference in the non-farm occupations of men and women. Women were more likely to take to trading, whereas men are more likely to take advantage of the construction work available, or have skills that allow them to operate as artisans or craftsmen. The data emphasise the tendency for a greater range of opportunities taken up by men than women.

Surprisingly, only 2% reported that they had supplementary occupations (although it was clear from KNRMP family case studies that there was diversification *within* many of the households; Nkrumah *et al.*, 1998). This lack

of diversity could be associated with the high rate of unemployment (17%) shown in Table 6.6. This was confirmed as an increasingly threatening problem in the livelihood studies, resulting from a lack of economic alternatives, a situation for which people were ill prepared (Nkrumah *et al*, 1998). Even young people with an education were unable to get a job (Blake *et al*., 1997a, p.39).

Table 6.6   Occupations of respondents in eight villages of peri-urban Kumasi, 1997

Occupation	Women		Men		Total	
	Number	**%**	**Number**	**%**	**Number**	**%**
1. Major occupation						
Unemployed	59	18	24	15	83	17
Farming	130	41	47	29	177	37
Salary (teaching, civil servant)	2	0.5	10	6	12	2.5
Trader/Business/Hotel/Restaurant	77	24	11	7	88	18
Construction/metal work	4	1.5	29	18	33	7
Student/pupil	28	9	9	6	37	8
Others, including artisans/craftsmen	20	6	30	19	50	10
2. Supplementary occupation						
None	315	98	156	97.5	471	98
Farming	3	1	3	2	6	1
Trader	1	0.5	--	--	1	0.2
Construction	0	--	1	0.5	1	0.2
Others	1	0.5	--	--	1	0.2
All respondents	**320**	**100**	**160**	**100**	**480**	**100**

Note: Percentages may not add up to 100 due to rounding.
Source: Derived from Kasanga (1998) Table 18

The KNRMP study included a survey of wealth perceptions among peri-urban, rural and urban villagers in the peri-urban interface of Kumasi (Nkrumah and Antoh, n.d.). According to the informants' perceptions (Table 6.7), the main determinant of the position of an individual in terms of relative wealth/poverty is their principal occupation or source of livelihood. Other groups identified in other studies include the landless, the homeless, migrants and youth, who still naturally fall into one or other of the above groups according to how they make their livelihoods, but who have a particular set of circumstances in common that have also been considered.

The only physical assets mentioned that specifically indicated relative wealth were house, car, number of farms and the corn mill. Ownership of livestock was not mentioned at all. Only two social factors (apart from occupations) were mentioned: royalty indicated relative wealth, and disabilities and old age placed people in the poorest group if they received little or no support from family.

Chiefs and the royal family have the right to sell land and this is associated with wealth, notably in the urban and one of the peri-urban villages, where pressure to sell land for development is more significant. However it was clear from the family studies (Nkrumah *et al*., 1998, p. 77) that women of royal families have lost farmland to development and no longer own any land themselves. There was also the instance where the niece and nephew of the chief in another village were unemployed, working on construction sites when the opportunity arose (Nkrumah *e al.,*p. 37-38). It may be reasonable to use 'royalty' as an indication of relative wealth for the queen mother and chief, but the benefits may not necessarily pass on to the least directly connected family members as might be commonly assumed.

The ownership of houses and vehicles (for private use or commercial use) indicate wealth, but these were the only material possessions mentioned in the characterisation of the different wealth strata in the peri-urban and urban villages. In the rural village (Swedru) the number of fields a farmer owns was also an indicator.

Cacao farmers were classed amongst the rich in all four villages, as were vegetable farmers, but the latter always hold a lower position of wealth than the former. In the urban and peri-urban villages food crop farmers were considered poor, and those farming small plots were in the poorest category. In Swedru, a more rural area, those with more than a farm were still considered amongst the wealthy.

Table 6.7   Perceived characteristics of wealth strata in the four study villages selected for the KNRMRP livelihood survey

Surveyed villages[a]	Wealth classification[b]				
	Poorest	Poor	Moderately rich	Rich	Very Rich
Apatrapa (urban)	Small scale farmers, unemployed, disabled/ aged, casual labourers	Craftsmen[c], kiosk operators, petty traders, cooked food sellers, food crop farmers on family land.	Shop owners, master artisans, vegetable farmer, mechanics, drivers, salary workers	Own a vehicle, managers, cocoa farmers, children abroad	Own house/car, royal contractors, business-men
Aburas (peri-urban)o	Small scale farmers, unemployed, unsupported disabled/ aged, casual labourers	Petty traders, cooked food sellers, construction workers, cobblers, food crop producers *Craftspeople, kiosk operators*	Craftspeople, kiosk operators *Master artisans, vegetable farmers, mechanics, drivers, salary workers*	Cacao farmers, traders/store keepers, children abroad, master artisans, vegetable farmers, mechanics, drivers, salary workers	Own house/car, royal (access to sell land), business-men, managers

a. According to KNRMP's Village Characterisation Study cluster definitions.
b. The items in italics represent the response of one of three informants who divided people into five categories while the remaining two informants only devised four categories. There are clearly subdivisions within the main strata. The same also occurred with the information from Apatrapa, where one informant identified six groups, where various crafts-people and kiosk operators were "moderately poor" as opposed to just poor. This is not a problem when all the information is presented as it is in the report and the method of analysis takes it into account.
c. Masons, construction workers, carpenters, hairdressers, dressmakers.

Table 6.7 (continued)   Perceived characteristics of wealth strata.

Surveyed villages[a]	Poorest	Poor	Moderately rich	Rich	Very rich
Duasi (peri-urban)	Small scale farmers, unemployed, unsupported disabled/ aged, casual labourers	Craftsmen, kiosk operators, petty traders, cooked food sellers, food crop farmers on family land.	Shop owners, master artisans, vegetable farmer, mechanics, drivers, salary workers, craftsmen	Own a house & vehicle, cocoa farmers, businessmen, managers, corn mill owner, children abroad	
Swedru (rural)	*Small scale farmers* unemployed, unsupported, disabled/ aged, casual labourers	Cobblers, petty traders, construction workers, cooked food sellers, *small scale farmers*/food crop farmers/ farmers with one farm	*Craftsmen, kiosk operators, farmers with more than one farm*[c]	Shop owners, traders Master artisans Vegetable farmers Drivers, *salary workers*. Craftsmen, Kiosk operators. Farmers with more than one farm.	Salary workers Children abroad Own house/vehicle Cocoa farmers

Source: Derived from the results described in Nkrumah and Antoh (n.d.)

Education was not mentioned as an indicator of wealth in the wealth ranking exercise, although the effect of higher education or skills acquisition is notable from the relative positions of occupations dependent on differing levels of education and skills training.

The learning of vocational skills as an apprentice or through training was one of the ways by which three in ten of the homeless hoped to gain a trade and escape their poverty. However, the opportunities were limited by the fact that training had to be paid for and tools bought. Even when one had completed training, the money required to set up in business was a major constraint (Anonymous, 1999a).

Those who have children abroad are considered wealthy. It is not known whether this is an accurate indication of wealth based on the education/skills levels needed by children to get jobs abroad, or based on significance of remittances sent home. The family case studies give some examples of those whose children abroad have not done well and are considered in a worse situation than they would be if they had remained at home. There are others whose grand-children are working in the US and Japan, and who send remittances, but the family head has still been classed as poor.

The livelihoods of the poorest group are characterised by a lack of security and dependency. The small-scale farmers may have to rent, sharecrop, or squat to obtain land, or simply do not have enough land from which to make a living. They do not have security of tenure. Casual labourers must rely on opportunities to work on a day to day basis, and this could also be said for the unemployed.

In sum, the poor are characterised by livelihoods that depend on limited markets (low turnover/value and much competition), do not require significant capital or skills investment, and involved in low productivity food crops. By contrast, the livelihoods of wealthier groups are the result of access to greater skills and education levels (businessmen, teachers, and civil servants), financial capital to initiate trade or other activities (purchase stock, land, tools, equipment), ownership of family assets such as the right to sell land, possession of cocoa plantations, access to land suitable for vegetable production, and children abroad who are able to send remittances.

Livelihood types help explain the higher relative poverty of women in relation to men. Women were involved in the less lucrative economic activities that tended to fall within the lower two or three strata, whereas the more highly capitalised and lucrative assets were more likely to be owned by men (Table 6.8).

The division of non-farm occupations according to gender and age is described in Blake *et al.* (1997a, Table 13).

Table 6.8   Wealth score for women- and men-headed households in the four KNRMP study areas (%)

Location*	Surveyed villages	Women	Men	Sex gap
Urban	Apatrapa	43	50	7
Peri-urban	Aburaso	48	56	8
	Duasi	45	51	6
Rural	Swedru	51	57	6

*Classification used in the KNRMP Village Characterisation Study
Source: Derived from data in Nkrumah and Antoh (n.d.)

It appears from Table 6.8 that the wealth gap between men and women is consistent across the urban-peri-urban-rural continuum but, as mentioned above, differences in the figures calculated will once again depend on the fact that the wealth strata were specific to each village.

The more urban the village is, the greater the number of wealth strata and livelihood types identified by the informants, indicating that livelihoods become more diversified with urbanisation, but that the gap between the richest and poorest tends to increase. Differing perceptions of wealth are indicated by the difference in positions of occupations (e.g. salary workers such as teachers) in the least urban and most urban villages.

The data in Table 6.9, comparing distribution of population of the four villages amongst the different wealth strata, should be considered with this in mind. A salary worker in Swedru was given the same weight as a contractor or royal in Apatrapa. As it is in the project's interest to know the effects of the process of urbanisation on the levels of poverty and the state of poverty in general, then it may be important to complement this study with one which examines such differences specifically. This study looked at the perceptions of relative wealth *within* a village community, rather than looking at how perceptions of wealth and poverty might compare or differ from those of the other communities in the study. For instance, it may be that a salary worker in Swedru has fewer problems meeting his livelihood objectives (educating the

children, obtaining adequate health care, and so on) than a salary worker in Apatrapa, where the costs of living (e.g. rent) are higher.

Table 6.9   Differences in perceived distribution of poverty and wealth among households in selected villages (%)

Location	Surveyed villages	Poor[a]	Rich[b]
Urban	Apatrapa	56 (8)	44 (10)
Peri-urban	Aburaso	49 (4)	51 (18)
	Duasi	54 (18)	46 (13)
Rural	Swedru	54 (9)	46 (21)

a.   Proportion of poorest shown in parenthesis
b.   Proportion of richest shown in parenthesis

Source: Derived from data in Nkrumah and Antoh (n.d.)

Finally, it is worth noting that in the KNRMP report the method used for the calculation of wealth scores was not clearly described. This might have facilitated a more confident and accurate interpretation of the data. Knowledge of how to compile average scores can be found in Feldstein and Jiggins (1994).

Analysis of asset status

Natural Capital

As discussed earlier, this is considered to be the capital commonly available to rural communities; it includes, among other things, land for production and housing, water, fuel wood, forest/wild foods, fodder and building materials. One the assets that is undergoing greater pressure as a result of Kumasi's growth is land.

Land tenure around Kumasi has been extensively studied in general terms by much research, and there is little doubt that the key elements of it are common knowledge. The details - who owns what rights to what pieces of land after changes affected by urbanisation - are perhaps not so well known. This research has identified the details of selected cases which could be indicative of general circumstances because public expression of them in many discussions, workshops, and distributed documents seems not to have been challenged by

locals. (Holland *et al.,* 1996a, p.33-37,38, Kasanga, 1998,). These are details of land ownership obtained by the PRA and the VC studies (Blake *et al,* 1997a).

As background to the discussion, it is worth reviewing briefly some of the basic notions behind the traditional land tenure system in the region, which has recently been placed under great strain by metropolitan expansion. The Asantehene is the overall custodian of lands under the powers bestowed on him when the stools of Ashanti towns were merged into one ancestral stool, the 'Golden Stool', in the early 18th century. The categories of customary ownership type recognised are the paramount (stools), sub paramount (sub-stools), family and usufructuary titles.   The system is hierarchical and at every level the subordinates each share the title to a portion of the total area. Fundamental to all Ashanti traditional practices and customary land laws is the fact that the land belongs to the whole community and whoever exercises the rights of holding or management does so in trust for the whole community. In practice, the chiefs and queen mothers exercise supervisory and administrative functions in respect to land allocation and as titular holders this applies to them (Blake *et al.*, 1997b).

A subject can acquire usufructuary rights by occupying and developing part of the communal or stool land. This is limited by the fact that forest can not be cleared past such natural boundaries as streams, thus regulating the physical extent to which a communal property could become individual and also providing easy identification of boundaries. The rights thus established are inheritable and transferable, but exclude rights to economic trees and other treasure trove found (ibid, p. 8). In other words lands thus acquired are the property of the individual or family and, according to case law, it can not, save with the express consent of the family or individual, be disposed of by the stool. Likewise an individual may not dispose of the stool's absolute ownership in it to strangers without consent of the stool (Kasanga, 1998, p. 25). If family lands became insufficient to provide for the needs of a family member, s/he could approach another family with excess land and negotiate either cash rental or the 'abuna' or 'abuso' tenancy arrangements that are similar to sharecropping in nature.

'Strangers' (those with no inherent right to occupy stool land) wanting to acquire land first approach the chief who then directs them to the sub-stool, family or individual, who gives them land - only under a grantor contract, according to custom and case law. A long undisturbed occupation does not ripen into absolute title and it is not transferable. However the stranger's interest will

endure so far as he does not break the laws of the area. The traditional 'abuna' and 'abuso' sharecropping arrangements were also commonly made with strangers.

The 1992 Constitution on the role of Customary Custodians of the Land upholds the traditional land tenure system, providing it with statutory backing and there are several instances of case law cited in the project documents where it has been upheld. The laws and institutions involved in land administration are discussed in chapter 2 of this book, but sufficient has been mentioned here to show that:

- Under customary, statutory and case law (at least on paper and in theory), families and individuals belonging to the stool are reasonably assured of access and security of tenure in their land holdings - subject only to the compulsory acquisition by the state and statutory land use regulations (Kasanga, 1998, p. 25).
- A basic tenet of the customary land tenure was the fact that it assured land to every family and individual for farming and other uses. Land leases under the customary tenurial system in the past were viewed as a foreign phenomenon (Blake *et al*., 1997b, p.22).

Increasing demand for land for residential, industrial, commercial and infrastructure development is resulting in rising land prices. Subsistence agricultural land has acquired a real value and an opportunity cost. Figures for rental value of land, rooms and for increasing purchase price of building plots are used to demonstrate the flourishing land markets in peri-urban Kumasi (Kasanga, 1998, pp.29-31).

Ninety per cent of the villages surveyed in the NRSP Kumasi Village Characterisation Study reported an increase in residential land at the expense of farmland and 11% had virtually no farmland left (Blake *et al*., 1997a). Land demand for housing is clearly the most important factor as compared with land conversion for economic or community purposes. In the survey on gender aspects of land markets in a context of peri-urban change (Kasanga, 1998), this was also found to be the most significant reason behind the conversion of agricultural land. Of the 232 interviewed villagers who reported recent conversions of land, nearly two-thirds said it was for residential use, while only 7% reported cases of conversion to commercial or industrial use (cf. Table 6.10).

Fifty per cent of women and 46% of men (48% overall) interviewed in that same survey reported having 'lost' agricultural land. The amount of their land that was converted has been summarised in Table 6.11. Of those who reported conversions, 71% had lost areas of over 0.8 ha, a significant proportion

considering the areas of remaining land holdings shown below. There was little difference between men and women in terms of the amounts of land lost.

According to Case Law, the stool cannot dispose of a subject's property, save with the express consent of the family or individual. However, in peri-urban Kumasi, of those who reported losing land few were consulted before conversion took place. Overall, only 33% of respondents were consulted and of those only 66% agreed to the sale/conversion of their land. That is, only 22% were consulted *and* gave their consent. And whereas only 27% of the women were consulted, 47% of the men were (Kasanga, 1998, Table 13). In Akokoamong Village, to cite one example, farmers displaced when their farms are sold cannot complain about it and obtain no compensation or alternative plot because the sale is decided by the chief (Holland *et al*, 1996b, p.19).

Table 6.10   Reported cases of land conversion from agricultural to other uses in eight peri-urban villages around Kumasi*

	Responses	
Agricultural land converted to:	**Number**	**%**
Residential	144	62
Commercial / Industrial	17	7
Education/ civic/ infrastructure	15	6
Combination of above	48	21
Others	8	3
Total	232	100

* The survey was conducted in 1997 but it is not clear from the report over what period the conversions refer to.

Source: Calculated from Kasanga (1998, Table 12).

A perusal of the data disaggregated by marital status of men and women shows that single women were more likely to be consulted than married women, but that married men were more likely to be consulted than single ones. In contrast to the significant overall difference in percentage of women and men consulted (20% in favour of men), there was little difference (only 3%) in the consultation of single men and women.

This highlights the significance of the issue of who in the family makes this decision and over which lands. Often in a couple, the woman has her own field

and the man his. The question then arises, to what extent are the respondents referring to their own or their spouse's fields in their answers? There does not seem to be information on this. Further gender-aware studies of this kind might shed light on the process to uncover whether this might be a significant factor for future research and development activities.

Despite the apparent customary and statutory provision for security of land tenure for the family and the individual (even strangers) described above, there are some key features of the land market and its management which prevent their continued positive influence. The stools may own the land and manage it on a day to day basis but the government controls all other decisions affecting the same land, from the timing of disposal to the distribution of revenue. The following describes some of the "inherent contradictions", as Kasanga (1998) calls them, that have the ultimate effect of enhancing the power of all other stakeholders, who stand to benefit from land sales to the detriment of families and individuals.

Table 6.11   Frequency and amount of land converted by village respondents from agricultural to other uses in eight peri-urban villages around Kumasi

Amount of land converted (ha)	Women		Men		Total	
	Number	%	Number	%	Number	%
0.04 – 0.8	48	30	22	30	70	30
0.81 – 2.4	63	40	31	42	94	41
2.41 – 4.0	24	15	8	11	32	14
More than 4.0	24	15	12	17	36	16
Total	159	100	73	100	232	100

* The survey was conducted in 1997 but it is not clear from the report what period the conversions refer to.
Source: Calculated from Kasanga, (1998, Table 12).

According to the "statutory underpinnings of the land ma described in Kasanga (1998, p. 27), various institutions are charged with the task of ensuring that development takes place within approved planning layouts/schemes. However, due to failures by the relevant state institutions in the timely application of these procedures, landholding individuals have responded to the increased demand for land often in direct contravention of laws. Some

plans waiting for up to 20 years for implementation have become obsolete, and developers wait on average four years for all of the relevant paperwork to be completed. Sometimes money is exchanged between purchasers of land before the necessary procedures have been carried out ensuring their tenure.

The effects of this are evident by the haphazard siting of buildings, underdeveloped infrastructures and associated environmental problems, and severe encroachment of public lands leading to arrests and prosecution of chiefs. Land disputes and litigation have become common between the state and chiefs, between communities and even between chiefs and subjects. This seems to be worse in the case of peri-urban villages according to the VCS survey, where 43% of peri-urban villages were found to have current land disputes, as compared to 20% of the urban and rural villages (Blake *et al*., 1997b, p.211). Litigation can last for years (e.g. Behenease's ten-year dispute with its neighbouring community), during which time disposals involving village lands are temporarily frozen.

Land Commissions have responsibility for coordinating the development of pieces of land with the relevant development plan (Brobby, 1997, p.86), and they must certify that "disposition or development" of land is consistent with the development drawn or approved by the Planning Authority (ibid, p.88), but they do not seem to do this in the Kumasi PUI. Village spatial planning and district planning have not provided strategies for how this might be done to serve any particular ends relating the PUI. There seems to be no overall planning for the whole peri-urban area or in one village with regard to another village (Blake *et al.,* 1997a, p.13, 15, Williams, n.d.). There seems to be no strategy for maintaining agricultural land (Blake *et al,* 1997a, p.15, Williams, n.d.). There is yet no strategic plan for the Kumasi Metropolitan Area which might consider options for such strategies.

The office of the Administrator of Stool Lands in conjunction with the Lands Commission collects ground rents from registered land developments. 'Drinks' money does not go to government, nor do ground rents from family-farmed land. (Blake *et al,* 1997a). All revenue, income royalties and so on, emanating from the sale or rent of land are to be paid into the various stool land accounts and shared as prescribed by law between the various authorities (10% to office of the administration of stool land, 25% to the stool through the traditional council, 20% to the traditional authority and 55% to the District Assembly) (Blake *et al,* 1997a). This 'sharing scheme' completely neglects the

compensation of families and individuals at community level for losses of agricultural land. It is supposed to provide the local traditional authorities with community development funds, but the extent to which funds are used for the specific and real benefit of the community is not always clear, although there are examples of this happening (Kasanga, 1998, p.39). Esereso Village has innovated by creating a Plot Allocation Committee which has taken charge of land sales and the distribution of proceeds (Holland *et al,* 1996a, 1996b, Blake *et al.,* 1997b, 3.19) which seems to have improved the flow of proceedings from land back into investments in the village, but this does not seem to give compensation to individuals.

Only 9% of the individuals interviewed in the Mazingira study (Kasanga, 1998, Table 13) who reported loss of land said that they had been compensated; 70% of these had indeed received their compensation from the chiefs rather than the developer. The main form of compensation was by providing the family with a building plot (41%) or cash (31%). Family heads whose lands are taken generally receive some compensation from chiefs, usually a share of the plots. A farmer does not usually receive compensation directly from the chief, but from the family head, and this may be land elsewhere or money. However, in the PRA studies many claimed to receive no compensation at all. Farmers sometimes receive on the value of their standing crops. There is overall a transfer of resources from poor farmers to rich chiefs and individuals (Blake *et al,* 1997a). Any land money which goes to community development may not necessarily benefit the poorest groups, as for example with electrification which may not be affordable (Blake *et al,* 1997a).

According to compulsory land title registration law, a security of title is provided through registration. The customary freehold is converted to leasehold subject to payment of an annual rent; in other words, indigenous people seeking to document their interest in land end up being tenants of the stool and government. These (and probably other) features of the land market mean that land not only is the main livelihood asset of the poor under increasing threat, over which they often have little control, but that they often receive no compensation for their loss. If they were compensated they might at least retain some security and capital with which to establish alternative livelihoods.

The Compulsory Land Title Registration Law 1986 (PNDCL 152) is thought to provide important protection to those with a claim to land rights, but it is said to be largely unknown to the poor, partly because of their illiteracy.

Consequently, for the moment it is the prevailing traditional tenure systems which offer the most security to the peri-urban poor rather than the statutory interventions which are too remote from them (Kasanga, 1998, p.55).

Figures on agricultural land tenure show that small farms are most common (Kasanga, 1998). Seventy-one per cent of female respondents had only one farm, compared with 65% of men, while 4% of women and 7% of men had three. Women tend to have smaller holdings, with 81% of respondents having less than two acres, compared with 75% of men (cf. Table 6.12).

Table 6.12 Size of land holdings among respondents in eight peri-urban villages around Kumasi, 1997

Size of agricultural land holdings (acres)	Women		Men		Total	
	Number	**%**	**Number**	**%**	**Number**	**%**
0.1 – 2.0	131	81	56	75	187	79
2.1 – 4.0	22	14	12	16	34	14
4.1-6.0	8	5	7	9	15	7

Source: Calculated from Kasanga, (1998, Table 19).

Of those who still had land amongst the Mazingira survey respondents (Kasanga, 1998), 14% (16% of women and 6% of men) had land outside the locality. Unfortunately the survey did not specify the type of crop grown outside of the locality.

The results show that between 59% and 69% still have access to land under customary tenure, while 29% have to rent or sharecrop (Table 6.13). These data could have been affected by the presence of many in-migrants who would traditionally be more involved in sharecropping systems, but a look at the description of respondents shows that this is not the case (Kasanga, 1998, Table 11).

Table 6.13 **Forms of acquisition of land by respondents in eight peri-urban villages around Kumasi**

Form of land acquisition	Women		Men		Total	
	Number	%	Number	%	Number	%
Customary allocation	99	61	40	53	139	59
Gift	12	7	12	16	24	10
Cash rental /premium/hiring	30	19	10	13	40	17
Share cropping	17	11	11	15	28	12
Other	3	2	5	7	8	3

Source: Calculated from Kasanga (1998)

With the reduction in quantities of land available, the system of leaving land to fallow is in decline. The Mazingira survey found that only 74% of land holders still practised a fallow and this was most frequently for only one or two years. The survey shows that there is a notable difference between men and women (Table 6.14).

The farm types differed with level of urbanisation. In the urban village of Apatrapa, undeveloped building plots are used for farming, and food crops such as maize and cassava dominate. In the peri-urban and rural villages farm sizes could be up to 0.4 ha or more, but few owned more than one farm. 'Forest crops' are still produced in the rural village of Swedru, as are plantains, cocoyams and vegetables. In the urban/peri urban areas there are places unsuitable for construction, such as marshy areas and steep slopes.

Table 6.14 **Prevalence and length of fallow among respondents in eight peri-urban villages around Kumasi, 1997**

Fallow length (years)	Share of respondents using fallow (%)		
	Women	Men	Total
1 - 2	66	21	54
2.1 - 6	33	79	46
Respondents using fallow	78	64	74

Source: Calculated from Kasanga (1998, Table 19).

With the exception of the information available from the Kwabre thematic maps (Adam *et al.*, 1999), in the Mazingira survey no mention was made of the proportions of people with access to safe drinking water in urban, peri-urban or rural villages. There is, however, some information about the percentage of villages with piped water and boreholes from the VCS survey (Blake *et al.*, 1997b, p.2). Access to such facilities seems to be limited to those who can pay. Water quality analyses have shown that villages are under threat from the effects of river water pollution, as Kumasi is atop the watershed. These two factors combined reflect a real loss and threat to the health of the most vulnerable members of a community. This is demonstrated by the example of the village of Duase (8 km from Kumasi), where the stream, used by those unable to pay charges for water from the standpipe, is heavily polluted from the KMA area (Blake *et al.*, 1997a, p.31). It is clear from stakeholder analyses that no particular party is made responsible for or is able to deal with this threat (ibid, p.22). There are examples of local customs and laws that are designed to protect streams. At village level the unit committees are responsible for the maintenance of water and sanitation facilities and the women clean the water facilities and village dumps regularly. However, it is environmental pollution on a wider scale that needs more attention.

Although some information exists about the potential for fish farming (see Chapter 4), it is important to note the threat to existing fisheries from pesticide contaminated water. It seems that, even if borehole or piped water was readily available and affordable by everyone, water pollution has some negative implications for the sustainability of certain livelihoods such as production of irrigated crops and fish.

Urban villages did not appear to have water supply problems, while this was identified as an issue in 8% of peri-urban and 33% of rural villages in the VCS survey. However, these data are general, being reported by few key respondents, and does not describe differences in access to water between various groups in the communities.

There is little information on how poverty and livelihoods are related to changing access to common property resources upon which the poorest members of a community are most dependent. Most of the information available is about control and access to materials of increasing economic importance such as sand and stone, but also firewood and charcoal.

When assessing the impact of urbanisation on the livelihoods of the poor, it is of interest to know the level of importance of these resources to the poor, the rate of decline of these resources and how the poor are compensating for this loss. It may be that the information exists within the data obtained most recently through the livelihood studies, but that these have not yet been sufficiently analysed to make them easily accessible.

Little timber is left in the Kumasi area (Blake *et al*., 1997a, p.38), but it seems it is still available at least for the use of local people (Nkrumah *et al*., 1998, p.63) from outlying villages such as Swedru (a rural village within the PUI). Timber access and control is described in detail in Holland *et al*. (1996a, p.48). Sand winning has increased with building activities and just under half of the VCS study villages (mostly within a 10 to 20 km radius of Kumasi) have sand winning sites (Blake *et al*., 1997a, p.36)..

The increased commercial value of these resources has resulted in their exploitation by contractors and village chiefs, who have allocation rights. This is to the temporary advantage of village labourers, but to the permanent detriment of the farmer who formerly used the land for production or fallow (Blake *et al*, 1997a, p.37), and for the community as a whole who suffer from the eventual effects of environmental degradation and loss of access to resources that they need themselves. It was noted that in Swedru homelessness was not an issue (Anonymous, 1999a), because families were still able to rely on the traditional allocation of land and locally available materials (timber) and even family assistance in terms of labour for the construction of houses for new families.

Traditionally, people have the right to forage for common property resources wherever these are found. However, even in Swedru village people had noted the decline in fuelwood, which used to be available from the forests and fallow lands. Now it can only be accessed from family farm and fallow lands. The increasingly short fallow periods mean that the trees do not grow to produce good fuelwood. In Swedru people purchase fuelwood only to supplement what they are able to collect themselves, whereas in villages closer to Kumasi, either charcoal and/or firewood was bought.

There is an adequately detailed analysis of the market and production of charcoal and collection of firewood and its environmental effects in the baseline study (Anonymous, 1999a, p.65). Adam *et al*. (1999, p.133) presents the results of a study into fuelwood gathering and use in the Kumasi urban area. The results demonstrate the continued availability of some fuelwood in the urban area; from isolated wood lots, scattered trees in residential areas (often ornamental) and fallow lands in the periphery of the metropolitan area; low density residential areas were identified as having a large tree population.

The gatherers work in groups of about five and cover a circuit of about 3 km (on average) from source to source, spending between five and eight hours a day. They earn about 3,000 cedis per day as this is the average price of a head-load, but are not well considered by residents, who think they are responsible for thefts in their areas. 168 head-loads of wood were counted entering the market in Kumasi. The distance covered by gatherers is little compared with Accra, where fuelwood comes from as far as 200 km (Adam *et al.,* 1999, p.131). However, as pointed out in the survey, despite the continued importance of the tradition of cooking with wood, its supply is taken for granted in the urban planning process. If some consideration is not paid to its preservation and even creation in communities, the scarcity will result in higher prices, the income source for local gatherer-sellers will be lost and the market will be supplied from distant areas by those wealthy enough to have the possibility of transporting it. Already gatherers complain that it takes a long time to find enough wood, it is rarely of the better quality, there is a lot of competition and access can be prevented to trees on private property.

The results of a set of family case studies (Nkrumah *et al*., 1998) demonstrate that some other resources like snails, leaves and mushrooms are still available despite the intensification of land use and ownership, although it is expected courtesy to ask permission to go on other people's land. There appears to be a bush meat market (Adam et al., 1999, Thematic map 1, p.6-7), but no other information is available.

No information was found about hunting rights or quotas, or the markets for bush-meats, fruits, palm wine, honey, or other such possible sources of incomes. Neither was there any indication of the current levels of exploitation of these resources or their location in relation to Kumasi, with the exception of fuelwood and charcoal, sand and stone.

Social capital

The impact of urbanisation on social cohesion has been well outlined in Blake *et al.* (1997a, p.52). The trend away from the traditional community spirit traditionally promoted by the chieftaincy was well described by respondents from the village of Duase (peri-urban Kumasi): "individual development has

succeeded communal development". This has been attributed to changing loyalties to the chief and increasing differences between the rich and poor (ibid.).

Loyalty to the chief is reportedly eroded firstly by increased numbers of 'strangers' (e.g non-indegenes) in the community, who are only bound to the chief by payment for a plot of land; they do not depend on the village for livelihoods or markets, have less input in community activities and more input into the outside community such as the church instead of traditional groups. And secondly, amongst indigenous peoples, loyalty to the chief is degraded by disputes relating to the sale of land and disposal of proceeds.

The relevance of the proximity of the residence of the chief to the village and the regularity of his visits was made in the VCS (Blake *et al.*, 1997b, p.2), as was a comparison between the ratio of in-migrants to indigenous people between urban, peri-urban and rural villages.

Attempts at researching and describing the relative survival and importance of the family social network have been made in the livelihood studies (Nkrumah *et al.*, 1998; Anonymous, 1999a), but once again it is difficult to obtain all of the information that could be available before a more comprehensive analysis is made. The strength and value of the extended family network between rural, peri-urban and urban and even wider afield should be determined from the family case studies already made.

After interviewing the homeless in the KNRMP study villages it was suggested (Anonymous, 1999a, p.17) that urbanisation causes a breakdown in the extended family system as a result of the inability of parents/ family heads to provide for basic needs. Traditionally a family bond situation is created by the knowledge that family lands are held in trust by the heads of families on behalf of the families. As these lands are lost to development, the bond is degraded. Young people can no longer depend on inheriting family lands. Overcrowding of family accommodation results in young men sleeping rough. Some young women in urban areas resorted to living with boyfriends, when their families could no longer cater for them. The fact that only one of the 11 homeless people interviewed was indigenous indicates that to a large degree there is still a great deal of support between family members, and that the housing and land situation is most adversely affecting those without family in the area.

The importance of connections in the city and elsewhere for finding occupations and living space for young women and men has been indicated in several of the family case studies.

The study into CBOs (Anonymous, 1999b) found that all villages had Unit Committees and Women's Groups based on religion. Other locally based groups differed in their objectives according to location. In the more rural area, the groups were agriculturally orientated (marketing and improving production). In the more urban groups, the objectives were welfare and development inclined, assisting the members in times of need, income generation activities, organising communal labour (de-silting drains and weeding) and sometimes acting as pressure groups on abuses on land use planning. In some villages trade associations provided "support" for the members when needed though there is no specific information in the surveys about what kind of support this consists of, nor by which means it is provided.

The functions of the most basic level of local government, the Unit Committees (UCs) are reportedly weakened by under-funding. The UCs have the power to collect revenue and resources from the community. Low education levels and an inability to co-ordinate efforts to strengthen their operations were also reported as one of the common constraints for CBOs. Links among CBOs and between CBOs and outside organisations (e.g. MOFA extension department) are stronger and wider in urban areas as compared to rural areas. Information flows may be less fluid as a result. The increasing interest of the churches in village development (with the increasing numbers of wealthy strangers in the congregation) and with their increasing interest in land should not be overlooked in terms of how much they can organise and contribute.

There is little information on the potential for church involvement in projects, or the experiences of CBOs and NGOs in different areas of intervention that may be of value to developing pilot projects and future strategies. The same could be said for the potential contribution of traditional leadership, but it is probable that this will vary quite significantly between villages and should be explored more deeply when the specific need arises.

Human capital

There has been no research into education levels, possession of skills, or access to schooling or training commissioned by the KNRMP, but some information is available in Kasanga (1998, Table 11) presented as characteristics of survey respondents. This details the proportion of respondents who had obtained each of the different levels of schooling, the levels of English comprehension and the difference between gender and marital status. According to these data, 77% of women and 45% of men can neither speak nor write in

English. It was interesting to note that 20% fewer married men were illiterate than single men, whereas there was no such clear difference between married and single women. This may be due to the fact that an education makes men more eligible for marriage, and/or because most of the single men were younger, and rates of education may have dropped in their generation due to decreasing ability of their parents to pay.

The livelihood studies have indicated the lack of education and skills amongst the poorest groups, and the fact that this is a major impediment for accessing adequate alternative livelihoods when land is not available to go into farming. For example, out of 11 homeless people interviewed only two were educated to middle school and one had completed training as a cobbler (Anonymous, 1999a).

No information was found on the changing prevalence of diseases related to pollution or changing occupations or diets or on how the general health status of communities has varied with differing degrees of urbanisation.

Physical capital

Several examples were found amongst the family case studies (Nkrumah *et al*., 1998) of those who were unemployed due to lack of funds to initiate business or trade. This was the case even for those with a higher level of education or training in a specific skill. Three of the homeless people interviewed had experienced loss of livelihood options through lack of tools (for carpentry and cobbling). This problem has also prevented respondents from obtaining or completing their apprenticeships.

Data were collected for the Mazingira study on the ownership of household productive assets (share of respondents owning livestock, domestic electrical equipment, motorised transport, plough, cart, and ox) (Kasanga, 1998, Table 20) in peri-urban Kumasi. There was no indication of the sale of assets as a result of increasing financial stress.

Overcrowding is prevalent, with as many as 15 people sharing a room even in Swedru, where housing construction was deemed to be less of a problem due to continued access to land and building materials. Even for the relatively wealthy owner occupiers, rooms are shared out between members of the extended family, with the result that they also have only one room for their immediate family. The baseline survey (Holland *et al.,* 1996a) shows that in tenement buildings there

are 40 to 100 people per household, with 20 to 50 people per household in indigenous housing.

Table 6.15   Perceived benefits of urbanisation among respondents in eight peri-urban villages around Kumasi, 1997

Perceived Benefits	Share of respondents (%)
Social amenities	44
Electricity	36
Hospitals	16
Employment	15
Markets	13
Transport	8
Schools	5

Source: Calculated from Kasanga, (1998, Table 19).

As Table 6.15 suggests, access to infrastructure and facilities were the main benefits perceived to result from urbanisation by respondents in the eight village Mazingira survey (Kasanga, 1998).

The value and importance of electricity was repeated in the family case studies, as many respondents were hoping that their village would be connected up to the network. Access to safe drinking water was not mentioned by survey respondents, despite the frequently mentioned widespread threat of pollution arising from the fact that Kumasi lies on the top of the watershed. Water analysis carried out in one of the peri-urban villages shows that it is of unacceptable quality by local and international standards (Kasanga, 1998, p.134).

Some village leaders have managed to attract these facilities to their villages using the revenue from land sales, e.g. Emena village where the queen mother and the land allocation committee have attracted a widely renowned hospital, electricity supply and pipe borne water. However, the reporter noted that the adverse effects of the permanent loss of family lands on the livelihoods of the community appear to outweigh the benefits of gains in terms of infrastructure and facilities

Access to electricity and water supplies is described in Blake *et al.* (1997a, p.45). Access is not so much related to proximity to Kumasi, as to the

willingness and ability of the chief to invest in the infrastructure and connection charges.

The share of villages with schools of various levels and health facilities is also reported, and this does not appear to be related to proximity to Kumasi either. The provision of education facilities is regarded as priority by villages and district committees alike. Sixty-seven per cent of villages had ongoing school construction projects at the time of the VCS survey (Blake *et al.*, 1997b, p.209).

The studies have also described access to transport and markets (Blake *et al.,* 1997a, pp.86-88; Holland *et al.*, 1996a, pp.43-45) and their operation. As a focal point of transport routes (road and rail) in the country, Kumasi is well supplied from outside of the region, by areas with competitive advantages for the production of less perishable commodities. Perishables or bulky crops still tend to be supplied from within the Kumasi area.

Only 3% of the villages in the VCS were not on a motorable road, and 76% were on managed tro-tros routes (local buses) and benefited from taxis services. The 12 tro-tros routes are regular although five have some flexibility according to changing demands (e.g. market days). For each route tro-tros charge a fixed price (200-250 cedis) whatever the length of the journey, as compared with taxis or trucks, the costs of which were related to distance travelled. The average cost of transport to Kumasi varied between the three village clusters identified in the inception report (Blake *et al.*, 1997a, Table 14, p.49).

The marketing of food crops in Ghana is characterised by a large number of private independent traders and large marketing firms and public sector marketing is rare. The existence or feasibility of co-operatives or producer group market associations and the associated efforts of individual farmers (or groups of) trying to gain marketing advantages has not been explored. However it seems that, following a long tradition of trade the Asante have a well organised local and regional market system. Markets are highly structured, with a variety of market associations concerned with the marketing of different produce. A queen mother who is elected by the association members for the purpose of maintaining order, including the fixing of prices heads each these.

The central market of Kumasi acts as a major consumer and relay market for Ghana and West African trade. Market queens were consulted about the daily interactions between the central market and the areas surrounding Kumasi. There are villages visited by Kumasi traders on a daily basis for the collection of produce to take to market, and vice versa, village traders who go early to Kumasi

in order to bring back perishables (meat, fish) and imported items to sell in the villages by 9 a.m. Within a distance of about 16 km villagers transport their own produce to Kumasi, whereas further afield they wait for traders or wholesalers to visit them. There was mention that some of the village markets closer to Kumasi have started to shrink as producers, traders and consumers become increasingly reliant on the bigger markets in Kumasi. Most farmers prefer to take their products to Kumasi themselves in order to take the opportunity to make their own purchases. They can also obtain cash advances from the traders they deal with there. Arrangements are sometimes made between farmers who contract local traders to sell their products for a fee, like an agent. They do the harvesting and loading and the trader uses her knowledge of the market in order to maximise the returns.

According to the KNRMP participatory rural appraisal research, none of the peri-urban groups interviewed reported any problems with marketing; they were confident that whatever they produced they could sell. Only in one village (rural Amaadaa) was marketing raised as a major problem. Produce had to be head-loaded at significant cost (500 cedis compared to 250 cedis to get to Kumasi by truck) from the market to the road to meet traders, who came twice a week only after being invited. They didn't always manage to sell all their produce. The main problem in Swedru (15 km from Kumasi) was that in times of gluts, there were no storage or processing facilities, and this forced them to sell at very low prices at harvest (Blake *et al.*, 1997b, p.20-116). Another village, Nyameani (30 km) had to sell fresh fruit such as oranges at very low prices to middlemen due to their perishable nature.

When considering the need to develop further enterprises available to poorer people in order to increase employment alternatives or supplements to agriculture, then information about developing the market for specific commodities becomes increasingly relevant.

It may be noted that in the reviewed reports there is a lack of information firstly on the feasibility of developing new products based on adding value to (processing) resources available (e.g. producing cheese, butter, yoghurt, refined honey, dried or sugared fruits, peanut better, fruit juices, dried or tinned tomatoes, jams, chutneys). And secondly, on altering the market strategy through the development of marketing/production associations, developing storage facilities to allow people to take advantage of seasonal price differentials, and cold chains for transport of perishables.

Some mapping of the main source of products sold, price differentials over seasons and between market locations would provide a useful tool. It would also be useful to determine the processing and storage practices already carried out or tried and the potential for the processing, storage and marketing of each different commodity type.

Financial capital

In the baseline survey (Holland *et al*., 1996a, p.21-22) a lack of finance and credit was reported in all the villages visited as a constraint to use of agricultural inputs and to diversification out of agriculture to other occupations or small businesses.

The importance of the informal financial institutions compared to the formal has been recognised, and the characteristics of the former have been described, and include 'susi' groups and traders. Research into the financing of small businesses has demonstrated the importance of people's own savings, or gifts or loans from relatives or friends in finding start-up funds. Gifts and loans from family to begin small enterprises were also frequently observed in the family case studies (Nkrumah *et al*., 1998). The success or otherwise of formal NGOs or CBOs to provide credit in the areas have not been described.The impact of changes on livelihood strategies and options

Urban expansion and the associated changes from farm occupations to non-farm alternatives have a number of consequences for the livelihoods of the peri-urban poor. Blake *et al.* (1997, p.39) describe the various push and pull factors influencing those who abandon farming, thus providing a useful summary of the impact of various findings discussed earlier (cf. Table 6.16).

Factors which push and pull people out of PUI farming have been identified (Blake *et al,* 1997a) and are presented in Table 6.16. Farming is decreasing as a means of livelihood (Blake *et al,* 1997b). Something is known about those who move out of farming and how they take up alternative occupations (Blake *et al,* 1997a). In general, young people, especially women, try to move out of farming as it is seen as unattractive and of low profit (Blake *et al.,* 1997b), either from families with no land to give them as inheritance, or those who choose to leave for more lucrative options (Kasanga, 1998). If individuals or their family have capital, they can acquire skills through training or apprenticeships and tools and start their own trade. If they are educated and have the necessary contacts they may find a city job. Otherwise they must depend on the less reliable sources of casual labour. The reported types of casual labour have been construction labour, farm labour and much less so, factory work. Except for the latter, these cannot be considered sustainable with regard to the rate of land use change and the patchy and temporary nature of building development. Duase is an example of a village where construction has been halted due to litigation, and people were looking forward to the end of this so they could regain their jobs. High youth unemployment is reported, even for those with an education.

Those remaining in farming may include women who cannot get out and who are stuck in poverty (Blake *et al.,* 1997a). Women tend to lack the resources to cope with the lack of available fallow land, and rather than attempt intensification, they are wringing the last fertility out of the soil, before giving up (Kasanga, 1998, p.68). But some men remain in farming carrying out opportunistic cropping on yet undeveloped plots or by virtue of sharecropping agreements in a neighbouring area (Blake *et al.,* 1997a). The decline in food cropping by women for household food may have an impact on household responsibilities to provide food (Blake *et al.,* 1997a).

Others who stay in farming tend to be specialist producers with enough capital to invest in profitable options or those who have so little in terms of assets that when their land is taken from them; they will have little alternative but to go into sharecropping arrangements in neighbouring villages, or crop verges or other waste-land in order to obtain a food supply.

Table 6.16   Factors behind shifts away from farming in peri-urban Kumasi

Factors pushing people out of farming	Factors pulling people away from farming
Low crop productivity resulting from increasing infertility with loss of fallow, (and a reluctance to invest in the land due to insecure tenure).	Perceptions of higher rates of return from alternative occupations
Removal of farm land (landlessness or near landlessness)	Possibility of commuting
Higher labour costs (due to higher costs of living)	Non farm jobs give immediate cash*
High transport costs for low value bulky goods (e.g. cassava)	

Source: Blake *et al*., 1997a

Figure 6.2 shows the impact of the reduction in availability of land on the alternative livelihood choices of farmers and their families according to what assets remain available to them. This analysis is based on Blake *et al*. (1997a, p.39), but Kasanga (1998) has provided data (described below) which can be considered in relation to the various lines of impact indicated in the figure.

The information provided by those who had lost land (or whose family had lost land) on how they were coping (or compensating for lost revenue) in most cases reflects the data on occupations (cf. Table 6.17). The high proportion (25%) of both men and women who were increasingly dependent upon relatives, and who had no alternative livelihood open to them at that time reflects the high level of unemployment and the lack of opportunities discussed above.

Table 6.17 Strategies used by people to cope with loss of land in peri-urban Kumasi (number of respondents in eight villages)

Coping Mechanism	Women		Men		Total	
	N	%	N	%	N	%
Acquisition of land/ Share cropping	21	13	5	7	26	11
Job hunting	3	2	3	4	6	3
Training in skills or profession (of which single people)	10	6 (80)	12	16 (50)	22	9 (63)
Out migration*	1		1		2	1
Business/trading/petty trading	40	25	7	10	47	20
Construction	3	2	8	11	11	5
Dependence on relatives / nothing	40	25	18	25	58	25
Others	42	26	19	26	61	26

- The likelihood of meeting people who have had to leave the area looking for work is obviously slim hence the low representation here

Source: Derived from Kasanga (1998, Table 13).

Equally important was the category "Others" which probably represents the mixed artisans and craftsmen (hairdressers, seamstresses, barbers, cobblers etc), although this definition is not made clear in the report. The importance placed on these options is re-enforced by the number in training for professions or skills, particularly the proportion of single people (24% of single women and 21% of single men).

Of those in training, 80% of the women were single and 20% married, compared to men, of whom 50% were single and 25% divorced/separated. This can be attributed to the fact that fewer people can pursue training when they are constrained by domestic responsibilities into which they must invest their time, energy and other resources, whereas the other options provide them with some immediate income. This is probably the main reason why there is such a difference between the proportions of men and women in training. By far the majority of the women carry out trade or crafts as their non-farm alternatives (especially married women: 28% and 33% respectively), while many men were in construction work (11%).

Farming was such an essential livelihood source for many (11%) that they were pursuing the same occupation to replace the fields they had lost. This may have been the opportunistic use of verges or empty building plots, sharecropping (4%) or renting land. This option was more important for women than for men.

The family case studies (Nkrumah, 1998) reported that, of the 14 family heads interviewed, only two had left farming, confirming the above findings in Kasanga (1998). However no such useful summary calculations were carried out for the rest of the family, so that although we know that the heads of families tend to still have farms, we cannot see the difference between them and their sons, daughters and grandchildren. This information may be available in raw form, but unless several hours are spent condensing and classifying the information in some 60 interview narratives in order to make the information more accessible it cannot possibly be used in the discussion.

Looking in a more structured way at these family (and also household) case studies in future stages of the project may help determine more objectively issues like:

- The different responsibilities and burdens experienced by different household members.
- The difference in livelihood strategies and options between members (according to age/generation, gender).
- The extent to which families support each other in developing their livelihoods (credit, farm land, education).
- Longer term strategies for developing a better livelihood; for example, do young people who go into vegetable production or even unskilled labour with the hope of earning enough money in the short to medium term to be able to invest in training and/or starting-up their own trade?

• Levels of diversification of income on an individual level and a family/household level.

A few differences in livelihood strategies between the three types of village, urban, peri-urban and rural where described in the participatory rural appraisal (PRA) results (Blake *et al*., 1997a, p.5). Dependence on agricultural livelihoods is higher in the rural villages, and daily commuting to Kumasi is more common in the urban and peri-urban villages but becomes rare in the rural villages at about 30 km from Kumasi. The PRA summary enumerates the widest range of non-farm income opportunities found in the literature so far. In the dormitory town of Abuakwa a sawmill, grain mills, block-making sites, a distillery, a chemical formulation plant, and poultry farms were identified as depending on the Kumasi market, whereas 'kente' weaving was the only industry mentioned for the two more distant (30 km) rural villages, the remainder of income generation activities identified depending on specialist agricultural or horticultural production. According to the PRA summary each settlement seems to have its own individual pattern of livelihood strategy adaptations to the peri-urban environment but the reasons for this were not suggested.

Fuelwood gathering was mentioned in the section on Natural Capital above. The gatherers are mostly women (92%) of 19-59 years of age, of low education status (85% illiterate), and have either no other form of employment (85%) or are employed in poorly paid jobs (15%). It seems that fuelwood is a source of revenue for many people, 120 having been found and interviewed for the survey carried out by the project. No extrapolation of this figure was attempted in order to estimate the approximate number of people depending on this for a livelihood in the Kumasi area, but it may be assumed that it is a significant number. As was pointed out earlier, intensive use of the wood sources in the city and peri-urban areas will, in the absence of control and regeneration activities, result in the loss of this form of livelihood, and in higher fuel prices for the residents.

Increasing vulnerability of the poor

Even those with land feel the need to pursue better livelihood options as productivity declines and land tenure is increasingly threatened. Those with the means can pursue lucrative alternatives, but many are left impoverished, either unemployed or with "un-remunerative employment" (poorly paid employment or unprofitable farming activities) that may not even allow them to meet their basic

needs. Kasanga (1998, Table 14) shows that many people have recognised poverty (42%) and general insecurity (10%) as adverse effects of urbanisation, whereas only 2% think urbanisation results in increased incomes. An increase in divorce and teenage pregnancy rates were reported as resulting from increased urbanisation by 12 and 22 of respondents, respectively.

That villages experienced a marked sense of personal insecurity as a result of changes becomes evident in the frequency of responses recorded in Table 6.18. Men and women who reported having suffered from food shortages numbered 60% while 73% reported an inability to meet the basic needs of the household or even to support it.

Table 6.18 Indicators of insecurity resulting from changes in peri-urban Kumasi (number of respondents in eight villages)

Indicators of insecurity* suffered personally	Women		Men		Total	
	N	%	N	%	N	%
Inability to meet basic needs	238	74	110	69	348	73
Unable to support household	243	76	105	66	348	73
Food shortage	196	61	91	57	287	60
Unemployment	187	58	75	47	262	55
Un-remunerative employment	104	32	51	32	155	32

* Insecurity of livelihood, i.e. vulnerability
Source: Derived from Kasanga (1998, Table 16).

The rising cost of living indicated by increasing rents with proximity to Kumasi has been described, as has the problem of overcrowding. Homelessness is a difficult issue to discuss or describe due to varying definitions used. Kasanga (1998) describes it as "those who do not have a roof of their own" or "have to beg to sleep in others' houses". This excludes "rough sleepers", who were the ones included in the homelessness survey (Anonymous, 1999a). Disregarding those data which are difficult to compare, and certainly in term of scale of homelessness is vastly different, we can still conclude that urbanisation has promoted this and other social problems. The cause of homelessness is said to be due to the high rents and people are known to move away from the city to become commuters in order to obtain lower rents. However it must also be due in part to the change in the availability and access to land and other natural

resources that would have traditionally been given to new families for the construction of new homes, leaving them to share space with their families. The higher costs of living in general were reported by 66% of people in the peri-urban area (Kasanga, 1998, p.89).

Pointers for future research on sustainable livelihoods in peri-urban Kumasi

The review of available documentation shows that the livelihoods of the poor have by and large been adequately characterised. It must be borne in mind that a sustainable livelihoods framework such as that outlined at the beginning of this chapter was not in place when the research programme was initiated, but was introduced well into the research process. However, some gaps in our knowledge remain which may have to be filled before future intervention strategies are drawn up to protect livelihoods and promote sustainability in peri-urban Kumasi.

Gaps remain in some areas such as a more systematic comparison between Kumasi and other cities in terms of land use change and employment trends. Chapter 2 documents the case of Accra, Ghana's capital city, which offers some lessons that may be applicable to Kumasi. This exercise may be extended to other similar case studies. As is also evident from the case of Accra, basic and reliable information is needed on the shifts in the proportion of village populations with and without access to clean water and sanitation facilities, as well as other amenities such as electricity and health services; changing prevalence of disease associated with contaminated water and poor sanitation, as well as other forms of pollution; the proportion of households of urban, peri-urban and rural communities able to send children to school (this is necessary to indicate the positive impact of increased availability of facilities while weighing it up against increased poverty preventing access of children from poorer families).

At the household level it may be useful to examine a range of questions such as: who in the household/family makes decisions over the disposal of land if consent is sought from household/family level? How do the responsibilities change within the household with urbanisation particularly considering the increasingly cash orientated household economics? Gender analyses are required, rather than a collection of data for a sample survey that stratifies response by gender and marital status. These answers may be used to confirm or reject a pre-conceived hypothesis, but they do not really allow us to understand the relationships and differences in access and control over assets within a household. Also how these factors differ between households according to wealth levels and how they are influenced by urbanisation is not made clear.

Similarly, lack of capital and/or skills in a trade where identified in the documents reviewed as barriers to sustainable employment but current systems for the provision of these were not explored. There is little on availability and access to credit, the successful or otherwise experience of CBOs and NGOs in providing credit, and attitudes towards credit for peri-urban enterprises. There is equally insufficient detail of actual and potential income generation activities from natural resources in the peri-urban interface, of the actual and potential contribution of larger scale industries or non-NR activities (engineering , mechanics, IT) and of the potential to improve incomes from improved marketing strategy.

In general, as was pointed out in chapter 2, it would be desirable to look more closely at the recent development of the peri-urban job market in the context of the regional and city economies. Further study should identify more examples of such local industries as described in the PRA, and determine the factors necessary for their initiation, success, their constraints and likely future. How many they employ, what skills are needed, and how jobs are accessed will also give more information on the potential for non-farm employment options for the poor. They will often be based on natural resources available locally and so may still be considered within the remit of the programme. Indeed the identification and testing of value added processing of agricultural produce was listed as a researchable theme in the inception main report (Blake *et al.,* 1997a, p.72), but if this has been done no report has been seen. There is little reason why a natural resources programme should restrict itself to agricultural products; many crafts and small industries are based on non-food crop natural resources, such as leather working.

Notes:

1 For an adaptation of the framework to urban areas, see Meikle *et al.* (2000).

2 All land available for cultivation, including fallow land not cultivated in the last five years, grazing land and permanent pastures, and land under miscellaneous tree-crops, including thatching grass, bamboo bushes and other groves.

3   Until 1998, Dharwad District had 17 talukas, or sub-districts. In 1998, the District was divided into three new Districts, and Dharwad now has only five talukas.

7 GIS and the peri-urban interface

Introduction

Cartography is as old as civilization, essentially unchanged over millennia until the last 10 or 15 years. The advent of readily available computers facilitated the evolution of Geographic Information Systems (GIS), which essentially was born as a way of digitising cartography (Miranda, 2000). It enabled the development of thematic overlays of conventional maps (e.g. population densities, land use types), which are descriptive uses, and spatial analysis allowing area, perimeter and volume calculations. Theoretically, GIS also allows qualitative spatial analysis such as diversity, proper or improper land use, simulation of alternative land uses, interactions between different land uses, probable impact of new agricultural practices on the environment, etc. In the peri-urban context, for example, this could encompass quantification of the expansion of built-up areas and new roads and their effects upon use made of land for agriculture or forestry. These possibilities spawned a series of GIS-based projects in the Kumasi city region, and these are described in this chapter.

Use of land can be described at several levels, or hierarchies: plot, field, farm, village, valley, watershed or district, each operating at a different scale. The type of technology employed to describe each level varies according to scale. For example, in Kumasi a satellite (SPOT) image taken in 1994 was superimposed as a layer over a 1974 paper map to determine the extent of urbanisation over that period. However, satellite imagery does not have the resolution to describe features at the lower end of the hierarchy. Here, aerial photography is a more appropriate technology, and this chapter describes how this has been utilised around Kumasi. GIS can also be used to generate thematic overlays from relational database management systems. Such a system (KUMINFO) has been developed for Kumasi, and was developed to assist planners.

This chapter will describe the situation in Hubli-Dharwad first, as this is the simpler of the two cases. In Kumasi there has been considerable input into developing a GIS, spanning several projects. The objectives and outputs of each sub-project are described here.

GIS and maps for Hubli-Dharwad city region

Map and GIS resources available, Hubli-Dharwad

University of Birmingham *et al* (1998b, p.196 ff.) gives a summary of the map and GIS information available for Hubli-Dharwad: The current (1998) software and hardware facilities being used for GIS are summarised (Table 7.1).

Table 7.1. Summary of map and GIS information available for Hubli-Dharwad city region

Type	Scale	Availability / Utilisation / Remarks
Topographic	1:50,000	Maps published in 1978. Rarely used in planning, partly because difficult to obtain from SoI, Bangalore, partly because of lack of "map culture".
Soils	All 1:250,000	Availability and use not known. Probably poor.
Geology		
Forests		
Drainage		
Major Irrigation		
Groundwater		
Census	1:126,720	
Urban Planning	>= 1:7,800	
Revenue Maps	1:10,000 ?	Revenue Department originals only. Details not accurate
Remote sensing data (University of Birmingham *et al*, 1998b, p. 200)		Karnataka State Remote Sensing Technology Utilisation Centre (KSRSTUC), Bangalore has capability to use remote sensing to map and monitor land use & water resources. Development of capabilities to apply work to PU problems and integration with GIS work of the District Natural Resource Data Management Service (NRDMS) is needed (University of Birmingham *et al*, 1998b, p.202).
GIS (University of Birmingham *et al*, 1998b, p.196)		NRDMS produces GIS maps on district basis, but not specifically for the PU project. Software & peripherals inadequate. Problems with matching locations of villages. Topographical sheets have been scanned - raster data only.

A summary of present users of GIS in the area is given in table 7.2 (University of Birmingham *et al,* 1998b, p.206).

Table 7.2. Users of GIS in Hubli-Dharwad city region

Organisation	Use
NRDMS	GIS used for district administration
HUBLI-DHARWAD Urban Development Authority	GIS being used for land records
KSRSTUC/ RRSSC	Have produced hard copy maps of Hubli taluk showing land use, land cover, soils - all being used by Principal Agricultural Officer
Forest Department	Have hard copy outputs from NRSA showing forests
Geology Department	Used for planning in coastal and mining areas

The picture is one of growing capability in GIS and satellite imagery but its use for storage and retrieval of maps seems to be more widespread than for planning and analysis. These skills need to be developed further if the technologies are to be of value to PUI projects. More analysis of the information entered onto GIS systems need to be undertaken.

The "Hubli-Dharwad Baseline Study" project (c.f. R6825) produced some thematic maps based on the 1981 and 1991 censuses, depicting changes in village populations (University of Birmingham *et al,* 1998a, p.19) and changes in number of landless people in 25 surveyed villages (ibid, p. 29). That is the entire extent to which projects based there have utilized GIS methodologies. Availability of maps for the area is limited (Table 7.1). One of the editors (RMB) attempted during the production of this book to procure 1:25,000 maps for the Hubli-Dharwad area from the Survey of India office in Delhi, but these maps were not in stock. The lack of maps and natural resource data to facilitate better planning has been remarked on by several authors (*e.g.* Fowler, 2000). The use of satellite imagery and aerial photographs to make up to date thematic maps is thus quite justified.

Application of GIS, GPS and ADPs in Kumasi

Introduction

As already mentioned, there has been considerable investment is establishing GIS in Kumasi. A list of resources is given in Holland *et al* (1996b). Unfortunately, the degree of integration between projects has not always been as great as it could be, although more recent projects have started to utilize and

expand the capabilities of the KUMINFO GIS. A range of software has been used for GIS in addition to the frequently used Arc-Info and Map-Info. Software had included Iconoclast (which apparently cannot export to any other software), Idrisi and Autocad. Clearly much better standardisation is needed, and KUMINFO has settled upon Arc-Info. Ways of integrating the utilisation and sharing of digitised information as well as making it more available is nevertheless still needed. Land evaluation maps at much larger scales than are available are also required if they are to be of use for local planning.

This section of the chapter is an appraisal of the knowledge generated by a series of technical GIS related projects, or GIS components within other projects. As these projects were principally determining the suitability of remote sensing for mapping purposes, they dealt with in this chapter in a document by document manner, unlike the format used in previous chapters. This approach was considered to be the most suitable for the following projects:

- R5149, "LARST CORE: Development of local satellite data reception" (duration 1989 to March 1996).

- R6347, "Integration of remotely sensed environmental data of different resolutions and spectral characteristics for natural resources management" (duration April 1995 to March 1996)

- R6799, "Kumasi natural resource management" (incorporating sub-project "Installation, support and maintenance of an integrated information system for peri-urban natural resources systems research") (duration January 1997 to March 1999).

- R6880, "Development of methods of peri-urban natural resource information collection, storage, access and management" (duration January 1997 to March 2000).

Further details of these projects are presented in Appendix 1.

R5149, "LARST CORE: Development of local satellite data reception" (duration 1989 to March 1996).

The overall objective of LARST activities was to improve renewable natural resource management by enabling local resource managers to obtain and use environmental information from satellites. This core component project concerns itself mainly with basic issues of satellite data reception and processing. Some development in this direction had already occurred as part of the construction of the NOAA Operational Manager (NOM) within the Africa Regional Project (T0480). This software combines NOAA data capture with downstream product generation. The NOM is also designed to be used in concert with third party software packages should such an application to be required. Success with the development of direct, real-time, in-country reception of NOAA data has stimulated the development of high resolution satellite reception capabilities.

The prototype tested core software: LARST satellite receiver systems for local reception and processing of data. The systems evolved throughout project and became more user-friendly and automated.

The need for very high resolution information was addressed by the airborne remote sensing research activities (AIS) involving low cost videography and digital camera systems. This work provides low cost accessibility to extremely high resolution information useful in its own right in urban locations and rural areas with small field plots but also offering another layer of detail for comparing and calibrating other data sources.

The use of GIS for data integration - focus on areal interpolation methodologies and their applicability to GIS in developing countries (provisional title) (Woodfine, 1994).

This components of the project consisted of a hort summary based on literature review of main methods used for areal interpolation in GIS. A key theme in GIS is the integration of different databases (which makes GIS more than computing mapping) and one of the key problems in data integration is the diversity of areal units (districts, provinces, post-code areas, etc.) in use for different purposes. This report also examined the literature on different methodologies to integrate different areal units (also know as areal interpolation).

The work consisted of a desk review of different areal interpolation methodologies. Review of the potential use of Ghana databases (maps, census, etc.) for GIS applications, and produced a very short summary of different aerial interpolation methodologies. The report recommended the "intelligent aerial interpolation (IAI)" methodology (Woodfine, 1994, p.7) which may use satellite images, census enumeration areas and commercial GIS software. However, the report suggests that even using intelligent aerial interpolation, it is not possible to claim totally accurate results. Therefore, users should indicate how the data has been derived and hence the likely inaccuracies. The report also argued that the 1984 census of Ghana provides valuable data for peri-urban studies around Kumasi. Although, the census in now considerably out of date and indications are that although a new census is planned, the spatial categories will be very different from those used in 1984 (therefore, the areal interpolation will be difficult).

Review of spatial data integration methodologies: Report on remote sensing in peri-urban areas in developing countries (Mather and Williams, 1996)

The production of accurate data using remote sensing presents several problems. These problems may be more exacerbated in peri-urban areas where a mixture of land uses, small plot sizes, and rapid change makes more complex the process of classification and data integration procedures.

The sub-project consisted of a desk review of main aspects of satellite images, a literature review on current application of remote sensing to peri-urban areas, an annotated bibliography containing 47 abstracts of material related to applications of remote sensing to peri-urban areas in developing countries (mainly on urbanisation and land use changes), and presented a list of telephone and e-mail contacts with institutions and professionals in developing countries which are working with GIS in peri-urban areas.

The short review presented details of different sources of satellite images; applications of satellite images for urban morphology; population estimation; change detection; technical problems with remote sensing including atmospheric distortions, sensor calibration, surface reflectance; a comparison between hard and soft classifications; and a review of classification methods. The report concluded that in the case of peri-urban environments, which consist of complex mixtures of a number of land cover types, the soft classifier methodologies are more appropriated. Also, the Grey Level Co-occurrence Matrix (GLCM) method of texture description is suggested as a mean of incorporating information concerning the spatial neighbourhood of a given pixel (Mather and Williams, p.19-20). The report suggested than even when appropriate studies do exist,

insufficient technical details have generally been included on the procedures adopted to overcome the potential problems of remote sensing applications in peri-urban areas.

Institutions and professionals in 24 developing countries that are dealing with remote sensing and peri-urban issues were surveyed, and results of the survey conducted to these institutions was presented. However, the response rate to their survey was disappointing. Possible reasons were that remote sensing institutions are difficult to contact and most of them are reluctant to disclose information which would be commercially-useful for potential rivals.

The report concluded that GIS and remote sensing have potential applications in peri-urban research in Ghana. The major limitation is the high cost of data capture for the base maps and specific layers or coverages (e.g. soil maps, population density,) from existing hard copies of maps (maps in paper format as opposed to digital maps) scattered around in different government offices in Ghana[1].

Spatial data integration with special reference to peri-urban areas and high potential agricultural areas in developing countries (Barr et al., 1999)

This component was a review of GIS and remote sensing applications for peri-urban research, similar to Mather and Williams (1996), but with a focus on research conducted in United Kingdom in GIS and remote sensing applications to urban, peri-urban and agricultural studies. It consisted of a desk review on the relationship between GIS and Remote Sensing, a short evaluation of different types of sensors (aircraft borne, satellites) and its potential for peri-urban research, a literature review on current applications of remote sensing to peri-urban areas in UK and a survey of methodologies for the integration of data on peri-urban and high potential agricultural areas in developing countries (95 UK institutions were contacted).

In its introduction to GIS and remote sensing including definitions and applications, it concluded that satellite based remote sensing is more useful for determining land-use but is inadequate for cultural features such buildings and roads. The level of detail required to identify such features and activities in the urban fringe implies large scale mapping such as those produced by aerial photography (Mather and Williams, 1996, p.7). Better mapping is the key to peri-urban analysis, however, its success will not lie in the nature of the sensor or the choice been aerial photography or satellite imagery. It will lie in the quality of the base map, and the attribute information that can be collected for areas

identified on that map (ibid p.8). The report also contains around 120 bibliographic references on GIS and remote sensing applications, around 215 abstracts on GIS and remote sensing applications (very general).

The survey of 94 UK institutions currently using GIS and remote sensing (not necessarily for peri-urban research) realised a response rate of only 12% (11 questionnaires submitted). Reasons for lack of response include the concern that NRI (Natural Resources Institute), which is seen as a commercial competitor, was seeking to obtain commercial valuable information from competitors. A lack of GIS and remote sensing applications for peri-urban research was postulated as another reason. The result of the 11 replies received indicated that the field (GIS and remote sensing) is, as yet mainly theoretical. The responses also indicated that peri-urban land use involves a mixture of built structures and natural vegetation. This complex mixture of land cover types, each of which has a markedly different spectral signature, makes conventional single pixel techniques inappropriate when using relatively low-resolution sources such as Landsat or SPOT (Mather and Williams, 1996, p.41). A two stage classification method is recommended as appropriate to deal with this problem. In UK, respondents were using UK mapping sources at scales of 1:10,000 - 1:25,000. This scale is seldom available in developing countries, thus information cannot be very precise.

R6347 "Integration of remotely sensed environmental data of different resolutions and spectral characteristics for natural resources management" (duration April 1995 to March 1996)

Modern remote sensing technologies give access to a very wide variety of natural resource data at different scales of resolution. Most natural resource managers require access to these data at more than one scale in order to provide useful information but there are important technological and methodological obstacles to be overcome to achieve this satisfactorily. This is especially true for the peri-urban interface where urban and rural resource managers traditionally deal with different classes of information collected at different scales.

The objective of this short project was to generate generic adaptive tools that would provide linkages to translate information between hierarchical levels (scales of resolution), to integrate information sets from each resolution level with data from sources (maps, GIS etc.) and to facilitate delivery of the above tools.

This is a range of diverse data sets relevant to Kumasi which have been installed in a well organised directory structure. The project produced an access

database which stores all the metadata relating to the spatial data sets, a GIS user interface, based on ArcView2, for displaying , querying and analysing the spatial and non-spatial data sets. The intention was that this would lead to a better understanding of what potential users may like to see incorporated into such a system. A technical manual was produced.

The availability of a GIS user-interface for examining a sample of data sets for Kumasi which allows users to examine various data sets and explore the spatial inter-relationships between different data sets, will allow a much better evaluation and understanding of how peri-urban production systems may be developing or changing and the subsequent environmental impact of such development or change. The better evaluation and understanding of the type, rate and extent of peri-urban change may lead to the better management of peri-urban resources, and to better control of environmental degradation and energy efficiency.

Airborne videography and ADP for high resolution mapping and monitoring

Curr and Curr (1996) describes a project to investigate the application of high resolution videography (HRV) and ADP to urban mapping, particularly the differentiation of vegetated / cropped areas, buildings and infrastructure. The work was done in connection with the Kumasi Geographic Information System - KUPGIS. This was developed by Bath Spa University College to look at the imagery from the aerial digital photography.

ADP was carried out in a light aircraft with very little specialist equipment apart from a small format control unit that managed to cameras. It was considered that ADP was superior to HRV. The location was identified using GPS and SPOT images and a published topographical map (dating from 1965). The ground resolution was 10 cm. The project successfully classified buildings (5 classes) and infrastructure (4 classes - 3 classes of road plus "rivers"). Vegetation was classified by type and activity as follows:

Type	Activity
Oil palm (mature)	Commercial
Oil palm (immature)	Domestic
Row crops	Unknown
Plantain	
Uncultivated	
Grassland	
Mixed (non-riparian)	
Mixed (riparian)	

It was thought that it would be advisable to extend the survey coverage from the sample area, develop the technology further and include a training component in a follow-up project but this seems not to have happened. The GIS system used MAPINFO software for data storage and presentation. Though not as powerful as ARC-INFO later used for KUMINFO, the software was more user-friendly and less expensive.

The design and development of a prototype peri-urban demonstrator for spatial data integration (PUDSI) (Geographic Data Support Ltd., 1996).

This component of the project consisted of generation of a GIS user interface - called Prototype for Peri-Urban Demonstrator for Spatial Data Integration 'PUDSI' -, based on ArcView2, for displaying, querying and analysing the spatial and non-spatial data sets for Kumasi, Ghana[2]. However, the lack of the actual GIS application PUDSI made it difficult for the reviewer to consolidate information on this project. Integrated maps extracted from PUDSI displaying data were available

The objective was that the GIS user interface tool would allow local decision-makers and planners to examine a wide range of data in a sensible and integrated manner which would not only lead to a better understanding of the information content of the data and the spatial relations between them, but also enable better decisions and plans to be made regarding the environment. PUDSI allows for sophisticated spatial and quantitative analysis (if good data is available for it).

PUDSI, GIS application which incorporate maps and database in ArcView2, was installed at NRI in April 1996. PUDSI incorporates the following data:

- Map of the World at 1:2,500,0000 (country boundaries)

- Digital Chart of the World for an area of 50km radius surrounding Kumasi City at 1:1,000,000. Data include contour lines, elevation levels, villages, urban areas, railways, roads, rivers and water bodies.

- Topographic data of an area around Kumasi City at 1:50,000 including rivers, roads, railways, village and large settlements/urban areas (based on maps from 1972 digitised by NRI).

- Map of Soils at 1:250,000 (from maps digitised by NRI) and related database.

- Districts associated with demographic data.

- A georeferenced digital image from Bath College (Swedru?)

- Theoretical application (with hypothetical data) on: river pollution, demographic data.

The report mentioned that the lack of clearly pre-defined user-needs and requirements, and the lack of available data for Kumasi limited the development of PUDSI. GDS argued that the Kumasi Baseline Study (R6448), which commenced after PUDSI projects, could have been an important source of information. As a result only a limited range of data was available to be placed on the system, thus, hypothetical databases were used to demonstrate the potentials of PUDSI. As a consequence of this, a limited range of possible functions were included in PUDSI.

R6799, Kumasi natural resource management (incorporating sub-project "Installation, support and maintenance of an integrated information system for peri-urban natural resources systems research") (duration January 1997 to March 2000) (Adam, 2000a).

The objective of this broad-based project was the sustained improvement in productivity of priority NR in the Kumasi city-region. Within this project, there was a GIS component., and specifically related to this, the project planned to analyse the impact of urban growth on land use patterns and access to NR resources (Adam, 2000a, p. 217).

A major output from this project is the KUMINFO GIS, which is based on the pre-project prototype, PUDSI. Users have specifically programmed interfaces that allow easy access to research topics. Development is continuing with specific water modelling routines as part of the "Kumasi Natural Resource Management Project at the Watershed Level" (c.f. R7330). The system is run in Kumasi, within the Institute of Renewable Natural Resources (IRNR), a constituent unit within the University of Science and Technology (UST), Kumasi. A parallel system runs at NRI and at Royal Holloway College, University of London.

- KUMINFO uses the following hardware and software for which commercial licences are required:

- Windows NT or Windows 95 platforms with 64 Mb RAM and at least a 4 Gb hard disk and a CD-ROM reader

- MS Office 97 Professional

- Arcview 3.1

- Arcview Spatial Analyst Extension

A large number of datasets is available for the KUMINFO system. Information about the datasets is held in a metadatabase that also governs the display and accessibility of data within the GIS. The KUMINFO managers in Kumasi, NRI and Royal Holloway College manage the metadatabase.

Data in KUMINFO consist of geographically references data, related text, numeric datasets and databases of project research results. A catalogue of data is automatically generated from the metadatabase.

At this stage it appears that KUMINFO is a potentially useful system in search of people to use it. To increase access to outputs from the GIS, CDs which can be viewed with Arc Explorer have been produced. District planners from the four districts adjacent to Kumasi collected a lot of data from the villages in their districts. The Arc Explorer software is extremely limited, but it does enable some map outputs to be available to the planners. Arc Explorer can present the data in different ways but cannot manipulate the data. The potential use of such software in the area needs careful evaluation. It was also intended that it would encourage them to use the more extensive datasets and GIS capabilities available at IRNR, UST.

Although the Arc Explorer version of the Kwabre district database contains an immense amount of data though it is of little help for examining land and water management issues. For example. there are no data on soil type, land slope, water quality details (other than good/fair/poor) or the existence of irrigated plots. Output of the area using the full Arc View software is considerably more

useful, and it seems to be a useful tool for general planning. However, at this stage little analysis of the data collected and entered onto the GIS systems appears to have been undertaken.

R6880, "Development of methods of peri-urban natural resource information collection, storage, access and management" (duration January 1997 to March 2000) (D'Souza, 2000a).

The objectives of this project were to:

- Determine and test the most appropriate scales and types of remotely-sensed imagery from which to derive PUI information.
- Determine how best the remotely sensing data may be used to involve local participants in the assessment of natural resource importance ranking and mapping,
- Development of a user friendly information system for natural resource assessment and management of a wide range of potential users.

Development of methods of peri-urban natural resource information, collection, storage, access and management: various document. (D'Souza, 2000b)

This report is a collection of several short documents which aim at reviewing literature on GIS applications, models for socio-economic appraisal and its integration on GIS and also a proposals for further research including the fieldwork in Kumasi in March 1998. The short documents include:

- A short desk review on methods for social appraisal including the Cochrane's Social Analytical Model (SAM) - an approach for national inventories of cultural resources - to collect social indicators for further integration in GIS.
- Desk review and evaluation of: the use of aerial digital photographic system for surveys in Kumasi, the use of microlight aircrafts, and the use of balloons for digital photography collection.
- Literature review of recent research in design and development of GIS user interface and review of specific GIS application for natural resource management in different countries.
- Literature review of some of the RRA/PRA literature related with the use of GIS, remote sensing, aerial photography, and participatory planning.

It was conclude from the review and evaluation of aerial digital photography system survey and aerial platforms that:

- Colour infrared aerial digital photographic system survey (ADPS) eliminate the difficulties associated with satellite remote sensing of cloud cover, ultimately coverage, slow data delivery and low resolution. The high resolution imagery from ADPS enables fine-quality mapping and high-definition classification of the peri-urban environment.
- The micro light platform - a low cost and compact aircraft - is suitable for small aerial digital photographic surveys due to its low-capital and low-operational cost. Page 6 shows the technical details (i.e. aircraft speed and altitude, camera settings) for the collection of digital photographs.
- The balloons platform - it is only suitable for very specific monitoring purposes where very high pixel resolutions are required

Finally the project opted for aircraft platforms.

The report concludes that GIS applications have been 'top-down', cadastral information is vital in any peri-urban GIS, institutional aspects of GIS are frequently of secondary importance or totally neglected. GIS should be a service provision. A comparison between RRA/PRA (in reference to participatory mapping and modelling) versus aerial photographs and other 'high-tech' mapping methods concluded that both methods have their benefits and limitations and an integration should be sought.

D' Souza (2000a) reviews international literature reporting the use of PRAs in conjunction with aerial photography. The use of aerial photographs in PRAs is proposed for Kumasi to allow villagers to assist in the interpretation of the photographs. Information about natural resources and socio-economic data collected during PRAs could be integrated into the computer-based information system used to manipulate and analyse the aerial photographs. There seems to be an assumption that the main (if not only) purpose of PRAs is to collect data from villagers for the purpose of planners and researchers. The empowering aspect of PRA work is ignored by virtually all the studies in both cities.

Estimating the datum transformation parameters associated with the Ghana National Mapping System. (Sannier et al., 2000)

Most spatial data in Ghana are not suitable for incorporation in GIS due to problems with incompatible geo-referencing systems. The project sought to find a mathematical formulae for the conversion of map co-ordinates between the

different projection systems currently (and potentially) in use in Ghana,.thus improving the use of GIS for the handling, integration and management of spatial information related to land use and natural resources from topographic maps, aerial photography and satellite images.

The project conducted a review of mapping systems used in Ghana, generated and an estimation of datum transformation parameters for the Accra datum using the Molodensky method. This was tested out Application of estimated parameters to a road survey data undertaken along the main ring road in Kumasi.

The project did produce an estimation of a parameters for datum transformation (Sannier *et al,*   p.7). The datum helps to convert maps co-ordinates to an homogeneous geo-referential system for their further integration in GIS applications for land use planning and NR management. However, the precision required by the Molodensky method (5-10m) was not achieved due to several sources of error in topographic maps and the SPOT image used.

Application of aerial digital photography to rapid rural mapping. (Thomas et al., 2000)

This component of the project sought to produce map products (in a short period of time) by processing of airborne digital photographs (ADP) and to demonstrate the capability of these maps for village rapid rural appraisals. This was done by:

- Conducting an ADP survey conducted during four days in December 1997.
- Testing the capabilities of portable equipment (PC, printers, software, etc.) in fieldwork
- Application of large-scale ADP derived image-maps for a village characterisation survey in Swedru (14 km north of Kumasi).

This report does not present the actual data on production systems in Swedru village, but just indicates the methodology undertook for the production of image-maps of Swedru.

Outputs from this project components were:
- 290 km^2 of Kumasi covered by ADP (1360 images at a nominal resolution of 0.23m)
- A database (21 CD-ROM's) of ADP images from December 1997

- One CD-ROM with mosaics of Swedru, Pease, Daku, Ahenema and Dakwankye villages
- Image-maps (derived from ADP) of Swedru village at 1:2,500 (Thomas *et al,* 2000, fig 2.)
- Characterisation of Swedru village using image-maps:
  - Identification of village boundaries: effective method and may help in boundaries disputes
  - Field, family land and farms survey: boundaries, total area, ownership, crops.
  - Built environment classification (Thomas *et al,* 2000, fig. 4a)
  - Household survey: number of family members, work load of the family (Thomas *et al,* 2000, fig. 6)
  - Mobility profile to assess the flow of resources within, outside and into the village: data on accessibility (time and distance) using image-maps and people's perceptions.
- Assessment of villager's capability to interpret ADP images: unequal capabilities to interpret maps.
- Production of family profiles for Swedru village. Information was overlaid onto image-maps at 1:10:000, based on fieldwork in March 1998.

It was recommended that thee should be further assessment of whether or not the availability of ADP derived image-maps could actually speed up the process of collecting socio-economic and natural resource data. The project argued that there appears to be considerable potential for reducing the amount of direct field observation through use of map products, although some level of field survey is normally required (Thomas *et al,* 2000, p.23). there should also be further investigation of technical procedures for production of image-maps from raw digital maps.

The application of satellite image-mapping for stratification of the Kumasi peri-urban interface. (Taylor et al, 2000a)

This component focuses on the development of a methodology for stratification of village level surveys in the Kumasi Peri-urban interface. It consisted of satellite mapping of villages in Kumasi peri-urban interface, converting the satellite image to an image-map of practical applications, and statistical and spatial analysis of the area and growth of Kumasi peri-urban villages. "Characterisation" of aspects of a geographical area to provide

information, upon which subsequent research or development must be based, is carried out either by collation (possibly with further processing) of existing data and/or by undertaking new studies or surveys. To facilitate the latter, prior to sampling, the area must be "stratified" by dividing the total area to be surveyed into sub-units which can be considered similar for the purposes of the study. In the studies so far undertaken (in both cities), stratification of the samples has rarely taken place.

Outputs from the study were:

- Production of a geo-corrected and visually enhanced SPOT panchromatic image[3]
- Interpretation of a SPOT satellite image acquired on 17 December 1994 which covered most of Kumasi peri-urban interface.
- Identification of 387 villages in the peri-urban interface of Kumasi
- Characterisation of 66 villages randomly selected using three criteria: on road (no more than 2 km from a main road); off-road (more than 2 km from main roads - based on 1:50,000 maps); within 5 km of the city centre main market.
- Stratification of villages according village size and growth 1974/94 (Taylor *et al*, 2000a, Table 3).

The study provided the methodology used to estimate villages' relative area growth from 1974 to 1994. The village growth data are then used to stratify villages on the basis of the current village size and growth rates of villages. It was noted that some villages had grown by as much as 2000% in area since 1972 (though most had grown by between 50 and 100%). The report on stratification suggests that a study on the relationship of growth rates and access to Kumasi is undertaken. Village size errors due to the occurrence of sand winning sites were noted.

The report concluded that satellite images provide a cost-effective method to collect natural resources data in large areas such as peri-urban interfaces. The report suggests the use of aerial (or "airborne") digital photography (ADP) to examine in a more detailed way, areas of the satellite images first identified by measuring differences in village areas. ADP is recommended for the collection of natural resource information for relatively small areas (e.g. small towns, individual agricultural fields). The application of satellite images for small areas could be limiting with respect to the spatial resolution (too large to see things in

detail). For PUI areas of more than 1600 km^2, ADP images are not recommended due to the large amount of data that will need to be collected and storage. Satellite images could be used for the peri-urban interface and ADP for targeting specific locations. Visual assessment prior to digital classification is important. For example, digital methods tend to classify sand winning (quarrying) areas - which is a common activity in PU Kumasi - as built environment thus enlarging the area covered by a village. However, the report does not assess how "transportable" the ADP methodology actually is. Nor does it assess the efficiency and cost of the proposed stratification procedure compared with alternative approaches.

The application of satellite image-mapping for stratification of the Kumasi peri-urban interface - Kumasi field visit report (Taylor et al, 2000a)

A number of activities were undertaken, including workshops with potential users of GIS: Environmental protection agency, University of Ghana, Ghana Water & Sewage Corporation, Kumasi Metropolitan Assembly, University of Science & Technology, and the Department of Forestry. They also conducted an assessment of villagers' capability to analyse the maps produced from ADP.

The researchers found that ADP-map products allow for identifying village and parcel boundaries, land use and rapid measurements of areas at local farm level. They also facilitated a detailed mapping of the built environment as demonstrated in Swedru village. Research with villagers showed that image-maps are more accurate than mental sketch maps produced during previous RRA exercises, but some features like drinking water or wells cannot be recognised on image-maps due to its resolution (0.23m), thus, the report highlights the need for the combination of map production and data collection in the form of Rapid Rural Mapping or other type of fieldwork visits.

One issue is that power cuts and lack of adequate GIS equipment makes it difficult to work with digital information in Kumasi. Power generators and the implementation of adequate digital systems will facilitate the processing of ADP and satellite images. The authors of the report (Taylor *et al.,* 2000a) also described the technical difficulties of matching GPS and GIS/map data because of different datum. The possible problems with the methodology actually adopted for the VCS (based on distance from road and markets) were examined.

Fieldwork indicated that each stakeholder group in Kumasi has different expectations of GIS images: University and Government bodies found image-maps useful for:

- Monitoring of illegal developments within the Kumasi Metropolitan area.
- Monitoring areas of potential pollution from stockpiles of sawdust.
- Monitoring illegal developments in the watersheds of the main reservoirs.
- Generation of an up-to-date city map.
- Services mapping and control of development on the UST campus.

The villagers of Swedru found the image-maps useful in establishing village and farm boundaries. Pressures on the land resources appear to be increasingly leading to land-ownership conflicts. Maps are also considered as a negotiation tool.

Following on from these findings, the researchers recommended that there should be:

- Further villagers' awareness raising and training in map interpretation and GIS technology:
- Another field visit focusing on specific cases studies such as: mapping of the UST campus, monitoring sawdust pollution, monitoring illegal encroachment upon the watershed of the reservoir.

GIS-based village level planning system. D'Souza and D'Souza (2000).

One of the most important changes in the PUI is the allocation of land, in particular, the rapid conversion of agricultural land to housing. This report illustrates the impact of potential new housing developments on a village community (Swedru) using an prototype GIS application. The aim of this component of the project was the development of a prototype GIS application to land use planning scenarios.

A workshop was held in Kumasi to disseminate previous project material on the village characterisation surveys (VCS), to publicise the KUMINFO GIS, and to invite feedback from planners. The project also developed a planning application using GIS for Swedru (chosen because of the quantity of information available). This involved:

- Generation of database: planning laws.
- Production of maps using GIS (sources: ADP images, and VCS).
- Development of scenario planning maps.

Swedru has 1500 inhabitants, with the majority being engaged in farming or farm-related activities. More than 90% of the farmers have farms in the village. Major crops grown are food crops (cassava, tomatoes, okra and maize) which are becoming very popular due to the proximity of the Kumasi market and recent improvements in the road network.

Several maps of Swedru were produced however, the scale of the maps does not allow precise planning applications. One map showed the age of housing (houses built in 1920, 1920-42, 1920-63, in the last 5 years). The map demonstrated the expansion of the area of new housing, which has more than doubled the village extent over the last five years and encroached on lands suitable for food crops. Backyard gardens (mainly planted with plantain) are common around these new houses, often as areas 'staked out' by people planning to build on them.

The maps also depicted:

- Built environment (physical features: type of schools, houses, cemetery, church, toilets, playing field, boreholds).
- Land use (derived from ADP mosaic and not fully verified in the field). This map indicates location (and statistical data such as area, perimeter, etc.) of: bush fallow, year 1 crops, year 2 crops, woodland, riverine vegetation, village boundary, sacred grove, roads).
- Slopes (derived from a digital elevation model (DEM), a tri-dimentional image showing the topography of Swedru).
  This map was generated from a 1:50,000 map, for real planning applications a more detail scale is needed. This map shows areas not suitable for housing development due to steep slopes.

- Rivers and drainage (derived from 1:50,000 map).

A buffer zone maps was generating showing areas not suitable for housing development following planning guidelines.

These led to the production of composite scenario maps indicating new development options for housing. This map shows four areas suitable for new housing development based on planning guidelines (slopes no more than 6°, areas beyond 5ft of a river or stream, areas beyond 100 feet of a sacred grove, distance from basic infrastructure and services). The four areas proposed were mainly bush fallows.

The project developed the following recommendations:

- The use of more than three planning constrains in order to refine the search for suitable areas of housing development.
- The use of more detail data (including local knowledge) on land use, slopes, distances, crop production, economic value of farms.
- GIS in watershed management

In the "KNRM Project at the Watershed Level" (c.f. R7330), water sampling sites (including sites sampled by a previous project undertaken by WSIP-Gibbs consultants) and location of survey villages have been mapped using GIS techniques CEDAR (1999, p.20). The presentation of histograms of chemical analyses at each sample site on the maps are not clear and may have been clearer on separate tables. GIS will be used to identify water use and environmental problems such as cultivation of river banks.

It was proposed that the project will use ADP because the images are easily corrected, because ADP can be used to locate the sampling sites on the ground (though GPS systems could also be used), because it can be used to provide an overview (from the air) of the sampling sites and because it can be used easily to identify devegetated areas around villages.

Conclusion

The potential of GIS for land use studies in rapidly changing interfaces such as the peri-urban zone is clear. Computer generated maps can be revised almost instantaneously as new data become available, whereas paper based maps are inevitably out of date within a year or two. The power to analyse spatial effects and changes is also apparent. However, despite the expenditure upon setting up a GIS in Kumasi, so far its impact has been minimal. It should be borne in mind that this system was generated within the context of research, and not development, projects. Nevertheless, the opportunity to use the power of GIS to help understand processes of change driven by rapid urbanization appear to have been missed.

Notes

[1] Maps in paper format need to be digitised or scanned to be incorporated in GIS. This process can be tedious, time-consuming and expensive.

[2] Arc Info is a popular GIS software. It has several modules which make it a very versatile and powerful GIS, however, the language it uses is very technical and requires substantial expertise in GIS. Arc VIEW is one of Arc Info modules which cost around US$2000. It provides an inexpensive way to display and analyse (with some limitations) spatial data.

[3] SPOT: French company which produces different type of commercial satellite images.

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