DEPARTMENT FOR INTERNATIONAL DEVELOPMENT

STRATEGY FOR RESEARCH ON RENEWABLE NATURAL RESOURCES

NATURAL RESOURCES SYSTEMS PROGRAMME

FINAL TECHNICAL REPORT

DFID Project Number

R6799

Project title

KUMASI NATURAL RESOURCES MANAGEMENT

Project Leader

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Organisation

Natural Resources Institute,

University of Greenwich

NRSP Production System	*Date*
Peri-urban Interface	10th. April 2000

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ABBREVIATIONS AND ACRONYMS

AEA	Assistant Extension Agent (MoFA)
Asante	Name of region and kingdom of which Kumasi is the capital, Ghanaian spelling
Ashanti	Same as above, anglicised spelling
ASS	Advisory and Support Services (DFID funding)
BIRD	Bureau for Integrated Rural Development, UST
₵	cedi (Ghanaian unit of currency)
CPP	Crop Protection Programme (of DFID research)
DFID	Department for International Development
DM	dry matter
ECEC	effective cation exchange capacity
EPA	Environmental Protection Agency (Ghana)
EPC	Environmental Protection Council (forerunner of EPA) (Ghana)
FAI	Forest-Agriculture Interface (DFID research programme)
FAO	Food and Agriculture Organisation (of the United Nations)
FFS	farmer field school
FM	frequency modulation
GDS	Geographic Data Support (private UK company engaged in DFDID research)
GIS	Geographical information system
GOAN	Ghana Organic Agriculture Network (NGO)
GUI	graphical user interface (to a computer program)
GTZ	Gesselschaft fur Technichse Zusammenarbeit (German Technical Co-operation)
HDRA	Henry Doubleday Research Association
IBSRAM	International Board for Soil Research and Management
ICM	integrated crop management
ILMAD	Institute for Land Management & Development, UST Kumasi
INM	integrated nutrient management
IPM	integrated pest management
KASA	Knowledge, awareness, skills and aspirations
KMA	Kumasi Metropolitan Assembly
KNRMP	Kumasi Natural Resources Management Project (this project)
KUMINFO	Kumasi Information GIS
MoFA	Ministry of Food and Agriculture (Ghana)
NGO	Non-governmental organisation
NPK	compound fertiliser containing N,P & K
NRI	Natural Resources Institute
NRSP	Natural Resources Systems Programme (of DFID research)
ODA	Overseas Development Administration
OM	Organic matter

PLUP	Participatory Land Use Planning
PM	poultry manure
PRA	Participatory Rural Appraisal
PSL	Production System Leader - former managerial position for DFID peri-urban research
PUDSI	Peri-urban Demonstrator for Spatial Data Integration (GIS)
RCC	Regional Co-ordinating Council
RCS	Regional Crops Specialist (MoFA)
RRA	Rapid Rural Appraisal
S/A	sulphate of ammonia (nitrogenous fertiliser)
SEM	Socio-economic Methodologies programme (of DFID research)
SPSS	Statistical Package for the Social Sciences (software)
TDC	town development committee (forerunner of unit committee)
UoG	University of Greenwich
UNCHS	United Nations Centre for Human Settlements
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UST	University of Science and Technology, Kumasi
VCS	Village characterisation study

EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

The **project purpose** as originally established was modified with the publication of the DFID White Paper in 1997. The overall purpose of the NRSP became to generate benefits for poor people by the application of new knowledge to natural resource systems. Accordingly the project purpose, which was originally

> ***"To achieve the sustained improvement in productivity of natural resources in the Kumasi city-region"***

became

> "To contribute towards the sustainable livelihoods of people in the Kumasi peri-urban area, based on improvements in the management and productivity of natural resources"

The principal research foci have been:

The effects of urbanisation on the control of and access to natural resources

The effects of urbanisation on the livelihoods of peri-urban inhabitants

Increases in agricultural productivity, especially through the use of organic wastes to improve soil fertility

Institutional issues related to natural resources management

The improvement of research and development planning capability by improving access to georeferenced data

The **activities** are summarised in Table 1

Table 1. Chronological sequence of project activities.

Dates	Principal project phase	Activities by project components			
		Land and livelihoods	**Soil fertility / urban NR**	**Planning**	**GIS**
February – October 1997	**Inception**	Village rural appraisals Village characterisation study			
		Land tenure study Stakeholder study	Waste stream products consultancy	Urban footprint study Workshop with planners	Establishment of system and training in Kumasi
November 1997 – March 2000	**Detailed research**	Household survey Wealth ranking study Family case studies Community-based groups study Homelessness study Land tenure studies	Supply & demand for soil ameliorants study Poultry manure trials Nutrient balance study Horticulture Mucuna trials Urban NR studies	Annual workshops with planners Study of existing district plans Environmental committees study Poverty study	Incorporation and analysis of research data and aerial digital photography. Creation of graphical user interfaces for research components. Training in UK.
February 1999 - March 2000	**Development of strategies for improvement**	February 1999 workshops			
		Participatory land use planning (PLUP) Strategies for income-generating activities	Poultry manure extension Compost extension	District planning information collection, inputting and development of demonstrator system and graphical user interface . Development of material to assist PLUP.	

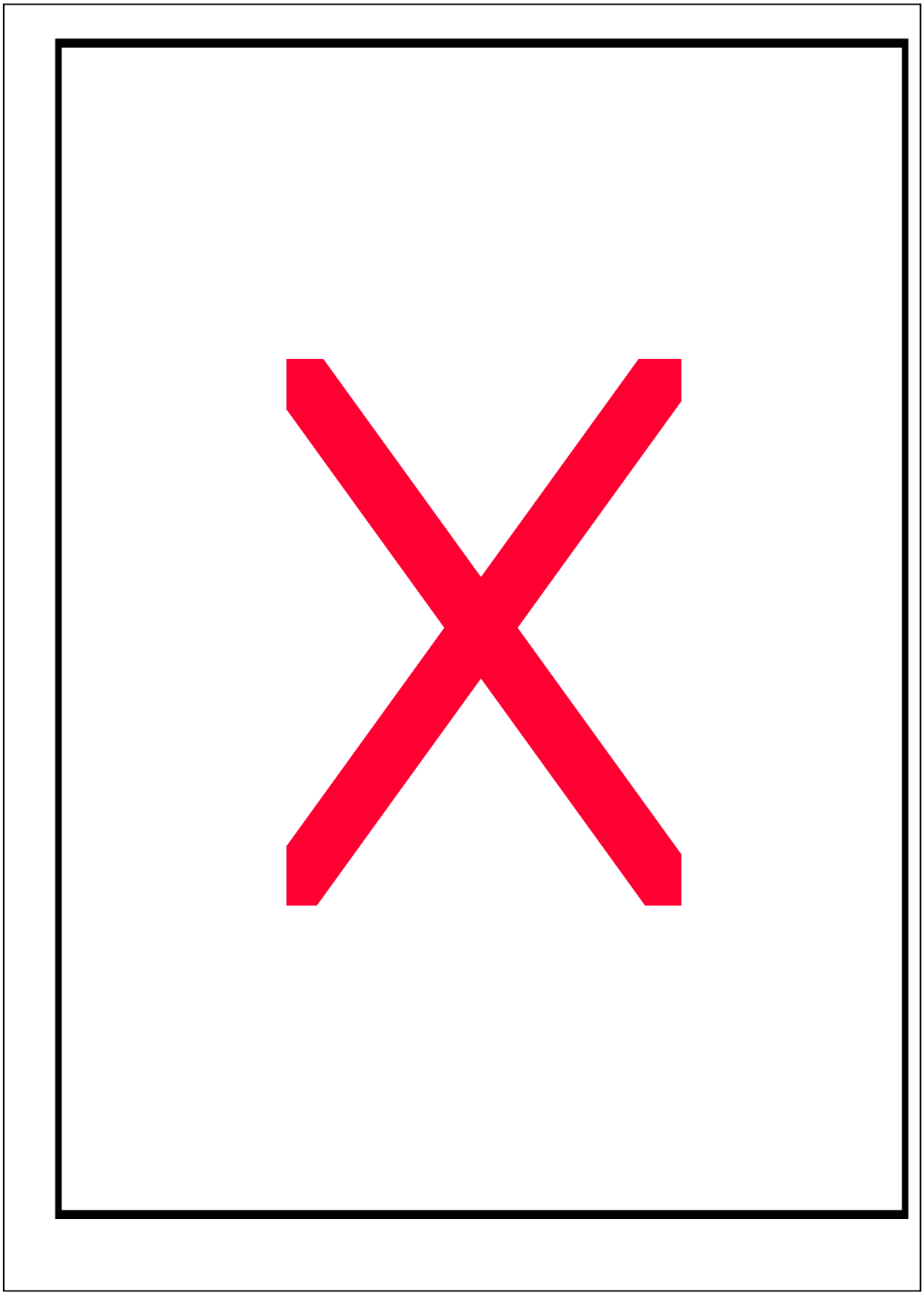
The **research outputs** comprise:

- Framework for improving land management and livelihood systems, particularly for low-income peri-urban inhabitants
- Frameworks for analysis, leading to understanding, of agricultural and natural resource utilisation (including urban Kumasi)
- Strategies for sustainable agricultural productivity
- Framework for analysis of planning constraints and information needs
- Strategies for improved planning processes, focusing on natural resource and environmental issues
- Information systems to aid research and planning

The outputs have **contributed towards DFID's development goals** by the direct involvement of communities in the planning of natural resource development and of the development of sustainable agricultural practices, and providing an information and planning framework for incorporation of environmental and natural resource considerations.

Figure 1 on the next page shows the study area and the locations of most of the areas where field work was concentrated .

Figure 1. Study area and locations of field work



RECOMMENDATIONS

The range of research and development proposals arising from the final project workshop is given at the conclusion of the "Contribution of Outputs" section. Research or development recommendations relating to institutional issues concerned with planning and environmental aspects are listed at Appendix 2. Some key proposals are highlighted below.

Further research

1. The project has demonstrated the possibilities for involving communities in the planning of land use developments in their peri-urban villages and the value of such involvement. The experience also showed that the efforts towards participatory planning will fall short of success unless the participation is integrated into an improved version of the presently disjointed planning process. Research is therefore needed to draw together the experiences of this project, others in Ghana, and internationally, to produce a set of definitive guidelines to legitimise the involvement of communities in planning for urbanisation.

2. A specific issue arising from the research on land tenure and also planning is that of compensation of cultivators and plot holders for land taken over for urban development. Again, the experience of other cities and countries could be investigated to assist the production of a set of procedures which could be practically applied.

3. Whilst the present project has established that organic soil ameliorants such as poultry manure and compost are effective and acceptable to Kumasi peri-urban farmers, more needs to be done to investigate and demonstrate the effects of good and bad handling practices of these materials.

4. Long-term and detailed studies to compare and assess the value of integrated crop management practices for peri-urban agriculture, also using cover crops to conserve moisture, and including pest and disease control, should be continued. This will also lead to the definition and characterisation of "loss of soil fertility" in the peri-urban situation.

5. Possibilities for setting up a framework of support for urban agriculture, possibly using funds from a development tax on building land, should be investigated.

6. The feasibility of extending the information storage and management systems established by the project (GIS and ADP) in support of planning for the Kumasi city region should be investigated.

7. Procedures for the provision of information to be held and developed by individual villages would facilitate a two-way exchange of ideas and information with district assembly departments. Guidelines are needed both to assist unit committees or other key village informants to handle, store or collect information of concern to their communities, as well as for the district assembly planners and policymakers to assist with this decentralisation of information-gathering process, thereby contributing towards the further development of community participation.

Support for development projects

1. Dependent on the recommendations of the study into the integration of participatory planning into the peri-urban situation, support and training for the establishment of such a system could be offered.
2. Based on the work of the present project, and on-going researches, information and training for intensified urban and peri-urban agriculture could be supported.
3. Training and apprenticeship schemes for appropriate coping strategies for the peri-urban situation should be supported. These will include livelihoods in natural resource dependent livelihoods e.g. crop processing.
4. Depending on the outcomes of the feasibility study on information systems for planning, support could be extended to equip and train planning officers and other stakeholders in the use of such systems.
5. Enhancement of the capabilities of local environmental committees through training, and logistical support for the Environmental Protection Agency in terms of training and equipment to strengthen its capabilities to monitor environmental change, could be provided.

Project management

1. The University of Science and Technology at Kumasi offers a wide range of potential collaborators who may be called upon to bid directly for research projects. Such bids may include requests for support equipment, as the university is not particularly well supplied with telecommunications or computer facilities.
2. The use of an overseas external accounting and support service such as the British Council greatly facilitates day-to-day project management.
3. However, for large multidisciplinary projects such as this, the DFID should consider allowing a proportion of time to be set aside by the UK bidders for administration and accounting at the UK end of the project as well.

BACKGROUND

Importance of researchable constraints

The tide of urbanisation in the third world is inexorable. Within less than a generation African cities will contain as many people as the whole continent holds today and an increasing proportion of these will be poor people (Koc *et al.* 1999). More of the rural poor are migrating to the cities, more of those born in cities are of poor families, and more urban middle-class residents fall below the poverty line. The UNICEF estimate that by this year, at the start of the new millennium, over half of the poor households in the world are living in urban areas of developing countries.

Those living in the shadow of the cities are experiencing the most rapid changes in their lifestyles and are having to cope with the most rapid rate of change. In these peri-urban areas the very land on which people depend for their livelihoods is being swallowed up and they are forced into the changes in lifestyle that others migrating from the rural areas, or those already urbanised, have chosen. The peri-urban people have little or no choice in the matter.

Recognising their predicament, the UK Department for International Development (DFID) has initiated a programme of research to analyse trends in technological, social and economic change in peri-urban areas, assessing the impact of change on the way that resources – physical and human – are allocated amongst the population. It is intended that the findings from this work will enable government and traditional authorities to establish policies and programmes that will best cope with the inevitable trend of urbanisation without displacing resources away from the poor, or potentially poor.

Identification of demand

In February-March 1995 Mr. C. Lewcock of the Natural Resources Institute (NRI) visited Kumasi on a mission to assess the suitability of the city-region as a focus for the peri-urban systems research programme of the then Overseas Development Administration (ODA) and to establish contact with potential collaborators. Those whom he contacted included academics at the Universities of Ghana at Legon (Accra) and the University of Science and Technology in Kumasi, researchers at various institutes, officials of government ministries,

representatives of regional and district government in the Kumasi area, professional staff at quasi-governmental or non-governmental organisations, staff at international aid organisations, chiefs and people of the Kumasi area.

Following his positive recommendations, a workshop was held at the Sir Max Hotel, Kumasi in August 1995, attended by a similar range of stakeholders to those visited earlier in the year.

The ODA considered the workshop's findings and commissioned a team of NRI researchers to collect and assess baseline information on the natural resources of the peri-urban interface, their utility, management and accessibility to a wide variety of stakeholders and from this to identify and prioritise major researchable themes as a guide for the future management of the research portfolio. The team was led by Mr. M. Holland and the principal members were Professor R.K. Kasanga, Mr. C. Lewcock and Ms. H. Warburton. The fieldwork was carried out during February 1996 and the report published in August 1996. It included several separately commissioned studies by local researchers.

At the same time NRI and GDS were commissioned to investigate the potential use of geographical information systems in the peri-urban situation.

Following a review of these reports, the ODA[1] called for proposals for a three-year multidisciplinary programme of research. It commissioned a lead team led by the Natural Resources Institute[2] in collaboration with the University of Science and Technology of Kumasi and the University of Nottingham. The team consisted of :

Dr. Barry Blake[3]	NRI Natural Resources Management Department, Project Leader
Mr. Martin Adam	NRI Natural Resources Management Department, Agriculturalist
Ms. Hilary Warburton[4]	NRI Social Sciences Department, Socio-economist
Dr. Keith Williams	University of Nottingham, Development Planner
Mrs. Judith Pender	NRI Environmental Sciences Department, GIS Specialist
Professor Kasim Kasanga	UST Inst. of Land Management and Development, Project Co-ordinator
Dr. K. Nsiah-Gyabaah	UST Bureau of Integrated Rural Development, Project Lead Counterpart[5]

[1] Later in 1997 the ODA became the Department for International Development, DFID

[2] The NRI became part of the University of Greenwich (UoG) in August 1998

[3] Dr. Blake assumed senior management responsibilities within NRI in 1999 and passed responsibility for project leadership to Mr. Adam

[4] Ms. Warburton became a private consultant in 1999

[5] Dr. Nsiah-Gyabaah took up appointment as Principal of Sunyani Polytechnic in 1999

Dr. S.J. Quashie-Sam UST Inst. of Renewable Natural Resources, Project GIS Co-ordinator

The present document is the report of this lead team, which began work in January 1997 and is completed on March 31st 2000.

Other collaborators during the course of the project are listed below:

NAME	ORGANISATION	COLLABORATION
Kingsley Boateng	IRNR	GIS data manager
Oppong Nkrumah	ILMAD	All land & livelihoods studies
Ernestina Freduah Antoh	BIRD	Land & livelihoods studies
Vesta Adu-Gyamfi	UST School of Art	"
Dr. Eva Tagoe-Darko	ILMAD	"
Dr. A. Owusu-Bi	BIRD	"
Samson Edusah	BIRD	"
Fred Amponsah	CEDEP	PLUP
Dr. J.Y. Kokor	UST Planning Dept.	Planning study
H.I. Baryeh	Lands Commission	Land tenure study
Dr. B.E. Kwesi Prah	UST Geodetic Eng. Dept.	Land planning study
Dr. Charles Quansah	UST Dept. of Agric.	All soil fertility studies
Dr. Peter Boateng	UST Dept. of Hortic.	Soil fertility studies
Dr. Joseph Famiyeh	UST Dept. of Agric.	"
Paul Sarfo-Mensah	(BIRD)	"
P. Osei-Bonsu	CRI	"
S. Osei-Akoto	MoFA	Agric. Extension exercise
Emmanuel Antwi	GOAN	"
Stephen Buabeng	BIRD	Planning studies
Tony Edmundson	ILMAD	Urban footprint study
Dr. Olivia Agbenyega	IRNR	Urban gaps study
Dr. W. Oduro	IRNR	Urban natural resources study
Mr. A.L. Dassah	IRNR	"
Sian Floyd	NRI	Biometrics support
Alan Mills	NRI	GIS training & programming
Richard Pole	NRI	GIS programming
Professor Philip Harris	HDRA	Soil fertility studies
Mrs. Nina Chachu	British Council, Kumasi	Local accounts & support services

Previous research

The city of Kumasi has been described and characterised by Korboe & Tipple (1995), noting its patchwork of developed and undeveloped, cultivated, land. The striking features of low density housing areas at the periphery contrasting sharply with multiple room occupancy at the city centre has been highlighted by Salifu (1995) and Afrane (1993).

The ethnic, kinship and social structures of the region have been extensively researched (Fortes, 1969, Hill 1963, Okali) and the hierarchical structure of the Asante tribal system described. The chiefly structure is still in place even in the most densely built-up areas of the city.

The pre-eminent role of the chiefs in the management of the natural resource base was confirmed by Holland et al (1996) and the roles of the various institutions impinging on land management and control reviewed. The same study outlines the range of land acquisition systems and notes that sales of land by chiefs are on the increase, in contrast to transfers of family lands - these latter revert to the chief when zoned in a town planning layout. The land rental market has been described by Malpezzi, Tipple and Willis (1989). Research carried out in the baseline studies (Holland et al. 1996) looked at how land was allocated and controlled around Kumasi, and how urbanisation was affecting this process. The nature of land tenure systems is a vital aspect influencing the gains and losses to different stakeholders and the resulting patterns of land use (GRET & IIED 1996, Benneh et al. 1995, Kasanga et al. 1995, Bruce & Migot-Adholla 1993). If land tenure systems are not well understood then strategies for sustainable land management are likely to fail. Traditional land tenure systems are not static but are modified by the changes in land pressures around Kumasi and interact with the systems laid down in the Ghanaian constitution.

It is recognised that individuals relate to a variety of social groups, and it is the mix of individual, household and wider (coping) strategies that allow them to cope with daily life (Rakodi 1991). Changes in access and control of resources include not only capital and labour but also access to social networks.

The 1984 agricultural census shows that 72-82% of the employed population is engaged in agriculture in local council areas around Kumasi, whilst this falls to 10% only within the municipality. There is a predominance of women farmers, some of whom, if they have the initial capital, engage in trading activities. Home-grown food forms a varying proportion of the diet of Ghanaians - 44% of the rural diet and 12% of urban (GLSS 1995).

Farming systems of the Kumasi city-region have been outlined by Holland et al (1996) as falling into five categories, ranging from bush fallow-food crop to backyard farms in new plots. Crop production data for six staple crops is collected by the Ministry of Agriculture's economics unit. Crop processing is often a women's' activity, as described by Kreamer (1986). Market pricing mechanisms, with particular reference to the market queens, have been debated by various authors (Clark 1994, Hine 1989, Gore 1978).

It is generally recognised from earlier studies that the critical determinant of soil fertility in the soils of the region is the level of organic matter, which supplies most of the nitrogen and some of the phosphorous requirements of crops as well as providing the medium

of exchange of other nutrients (Wills 1961, Abu 1992). Most soil nutrients are concentrated in the top few centimetres of the profile, therefore relatively small amounts of soil loss can have a disproportionately large effect on soil fertility. Nutrient budgets have been investigated in the city-region of Kano, Nigeria, under NRSP funding (Harris & Bache 1995, Harris 1996) and these studies point out the key role of the recycling of crop residues as animal feed and that labour availability for the transport of organic waste to the fields is a critical factor in sustainable farming systems. It has further been pointed out that traditional organic inputs such as crop residues and animal manures cannot however meet crop nutrient demand over large areas because of the limited quantities available, the low nutrient content of the materials and high labour demands for processing and application (Swift et al 1997).

Farmers often prefer to use inorganic fertilisers, which have the advantage of relatively obvious, immediate and predictable effects, whereas organic manure may be slow-acting, unpredictable (if misused) and harbour diseases and weed seeds. All these are observations made by farmers in the Kumasi region as reported by Harris (1997). There is a preference for the use of exogenously-derived short-term fertility restorers such as inorganic fertilisers since they are in concentrated form, thus reducing transport costs, and simple to use. However, as has been pointed out (Allison & Harris 1996), if a farmer does not have cash to buy fertiliser, then organic composting is his only chance to improve the fertility of his land.

There have been positive indications from trials carried out by IBSRAM (Quansah et al 1997a) that poultry manure can be profitably used on maize and cassava in the Kumasi area, and those farmers who do use the material comment on its efficacy in terms of yield and high quality of produce. It has been noted (Quansah, pers. comm.) that in those villages where there is ready access to poultry manure and trials have taken place, there is increased demand for the material, which could lead to poultry farmers charging for it. A precedent for this in an African peri-urban environment is found around Nairobi (Harris 1997) where there is "a well-developed market" for manure. The Nairobi farmer purchasing manure has a preference for poultry manure and cattle manure from animals fed on natural grass pastures (e.g. Masai cattle) rather than crop estovers, which it is believed, may carry crop diseases.

Composted municipal waste, including human sewage, is produced on a large scale in Accra; the demand comes largely from institutions rather than individual farmers. Its use on vegetables in the Kumasi area has been under investigation by the associated CPP "Composts to Control Pathogens" project currently operating in the peri-urban area; crops have shown early good response to the compost. There is presently no local source of such centrally processed material in Kumasi, yet there is great potential for the use of sewage wastes; however, cultural prejudices against its use are anticipated. Yet, remarkably enough, in the Tamale area of the north of Ghana it has been reported (Owusu-Bennoah & Visker 1994) that

farmers were hijacking septic tank emptying vehicles to release the raw nightsoil over their fields. It is considered that it would be relatively straightforward to downscale the technology for sewage waste composting, thereby largely removing the health risks associated with use of human manure, to the individual household level (Holderness 1996). Waste management in Kumasi has been reviewed by Salifu (1995), Lopez-Real (1995) and Holderness (1996) and the studies point out the generally environmentally deleterious practices and the lack of recycling except for the use of brewery waste and cassava peelings as animal feed. Techniques for the use of nightsoil have been studied at the University of Science and Technology and described by Holderness (1996).

As an alternative INM technique, the use of cover crops such as *Mucuna* to improve and sustain soil fertility is under investigation by the NRSP FAI project on soil fertility in Brong-Ahafo. Although it has been surmised (Osei-Bonsu and Asibuo 1995) that where only short-term land tenure is available the investment in such cover crops is likely to be undertaken by only a few farmers, it may be that a demonstration of their value would encourage more of the landowners themselves to take up vegetable production.

Findings of a number of studies of urban agriculture in African cities (quoted in UNCHS 1996) have shown a pattern of poor women practising urban agriculture in order to provide food for themselves and their families. However, in Lomé, as in our surveys of the peri-urban area, it was found that most of the market gardeners were men. In urban areas of Tanzania it is the retrenched civil servants who are leading in the urban dairying sector (Sumberg 1996). The latter author questions the equating of food production in towns with improved security for poor people and stresses that the significance of urban-rural interactions should be considered in explaining the survival capabilities of the urban poor.

In general, it appears that the Kumasi city authorities have not been so draconian in their attitude to urban agriculture as others in Africa. In Harare, standing crops on dambo (valley bottom) lands were regularly destroyed on the pretext that their cultivation interfered with the natural hydrology of the dambos and their contribution to groundwater flows - although the harbouring of muggers was also cited (Bowyer-Bower and Drakakis-Smith 1996). In other countries such as the UK, urban agriculture has long been encouraged in the provision of allotment gardens by local authorities, although the legislation, which dates back to 1908, is in need of revision, being “vague, obsolete and incomprehensible”. Nevertheless, the tenacity of local people in hanging on to their allotments despite erosion of legal protection of tenure provides examples of what empowerment can do to challenge unsustainability (Garnett 1996).

A prototype Geographical Information System (GIS) was developed to handle natural resource datasets for the Kumasi city region during the baseline studies

period. The system was developed to demonstrate how GIS can assist in research into the rational management and understanding of patterns and processes in peri-urban areas and is called the Peri-Urban Demonstrator for Spatial Data Integration or PUDSI (Geographic Data Support Ltd 1996).

In a spatial sense the integration and management of data into one geographical system removes inconsistencies in data from different sources and at different scales by dealing with the data in a regular, prescribed manner for all users. A unified information system, centrally managed, overcomes some of the common problems of data-exchange such as different map projections (and datums), co-ordinate registration, feature generalisation, edge matching problems, scale conversion errors, co-registration of maps and images and aggregation of data classes to a common level (Shepherd 1991). Where problems do exist they can be documented and users are not plagued with devoting time to overcoming them.

During the execution phase of a GIS, essential activities of an implementation plan have been identified as training of users and support staff, data capture and product development and continued performance monitoring (Shepherd 1991). The successful achievement of all these activities will enable user expectations to be met and the successful use of the system (Chorley 1988). Continued dedicated maintenance of a GIS also enables the effective use of project resources, helps plan future activities and therefore improves the overall effectiveness of the research (Cornelius 1991). This project proposes such a continuing management of the PUI information systems and encompasses the training needs of users and support staff.

The development of large integrated spatial and non-spatial databases makes it necessary to keep records about the data. These records should provide information on the nature of the data, the sources of derivation and the quality of the material. Such a metadatabase prevents duplication in the collection of data, improves access to data, standardises data formats and increases flexibility in use of the data (Cornelius 1991). All these factors enhance the value of any data in a system but are often poorly developed due to conflicts between speed, cost and consistency in the development and use of such databases (Newmann 1991). However, metadatabases have been successfully developed, for example the UNEP GRID database which holds country information for Africa and Latin America and directs users to suppliers and originators of the data rather than supplying the data directly. The implementation of a GIS such as PUDSI, which will be used by several research groups and decision making organisations requires that a rigorous metadata handling system is developed from the outset which will reduce the conflicts envisaged by Newmann (1991).

PROJECT PURPOSE

At the 1995 workshop referred to in the previous section the overarching theme of the research was seen as the achievement of sustainable agriculture at the peri-urban interface and the areas highlighted for attention were waste management strategies and watershed / catchment management. Energy utilisation was identified as a secondary priority. In addition, two key cross-cutting areas were identified - the establishment of effective urban-rural information bases and the analysis and evaluation of institutional structures.

The baseline studies provided a natural resources profile of the Kumasi city-region. They did not try to define spatial limits to the peri-urban area, not least because these were seen as "moving targets" as the city expands. It was perceived that technical solutions to agricultural intensification were available but that the workings of the farming system as a whole required deeper research to facilitate the deployment of such technologies. Land management was suggested as the priority research theme, to be addressed together with water and waste management, planning processes and remedying the very substantial deficiencies in natural resource information in and around Kumasi.

The present project as commissioned in 1997 incorporated the first phase of an originally separate DFID NRSP project to install, maintain and support an integrated information system for the peri-urban area, using GIS. In later phases of the KNRMP this "GIS Maintenance" project became an integral part of the KNRMP. On the other hand, a project to develop methods of storing and managing peri-urban natural resource information using GIS in peri-urban Kumasi ("GIS Development") was retained separately and managed by Geographic Data Support Ltd (G. D'Souza) as R6880. The original suggestions for watershed research were taken up and separately commissioned as the Kumasi Watersheds project (R7330), under the management of Royal Holloway University of London (Dr. D. McGregor), in 1999. These separate projects are also commissioned under the Natural Resources Systems Programme of the DFID Renewable Natural Resources Knowledge Strategy.

The overall aim of the KNRMP, as commissioned by DFID, is to contribute towards the sustainable livelihoods of people in the Kumasi peri-urban area, based on improvements in the management and productivity of natural resources. Its principal research foci have been: -

1. The effects of urbanisation on the control of and access to natural resources;
2. The effects of urbanisation on the livelihoods of peri-urban inhabitants;

3. Increases in agricultural productivity, especially through the use of organic wastes to improve soil fertility;

4. Institutional issues related to natural resources management;

5. The improvement of research and development planning capability by improving access to georeferenced data.

Following the inception phase of the project, a review of the findings led to the revision of the project memorandum, with the following principal changes, refinements or adjustments in direction:

a) On land tenure issues, firstly, to refine the research to provide information in order to inform policy at all levels on land control and management and its consequences in the peri-urban area; secondly, to move forward into developing more sustainable and equitable land management strategies.

b) On livelihoods in general, individual and household case studies and the structures and operations of existing community-based groups were identified as requiring attention in order to provide an understanding of coping strategies as a prerequisite to developing appropriate livelihood strategies. The focus was shifted to the more vulnerable groups, such as the food crop farmers and those who have been displaced from their land, concentrating on activities which utilise natural resources.

c) Soil fertility research was to focus on the inventorisation of soil ameliorant resources, notably urban waste products; the development of decision trees to aid adoption of soil integrated nutrient management (INM) techniques; appropriate INM for long and short-term situations; and agronomic practices in the application of INM.

d) The identification and description of urban (as opposed to peri-urban) natural resource production systems and those who depend upon them was identified as a new project component which will be of use in planning waste management, agricultural extension and welfare programmes in the KMA area.

e) The continuation of the GIS maintenance project, following its first phase which had been incorporated into the KNRMP, formally became an integral part of the project. The development planner and the GIS specialist were to work together to analyse information requirements and develop a pilot planning application of the KUMINFO GIS.

The project activities and outputs are grouped for the purpose of this report under the following headings:

General, land and livelihoods (lead researchers Ms. Warburton and Professor Kasanga)

- Village Rural Appraisals
- Village Characterisation Study
- Specialist studies
- Household survey
- Wealth ranking study
- Family case studies
- Community-based Groups study
- Homelessness study
- Land tenure studies
- Participatory Land Use Planning
- Strategies for income-generating activities
- Workshops and dissemination

Soil fertility (lead researchers Mr. Adam, Dr. Nsiah-Gyabaah and Dr. Quansah)

- Waste stream products consultancy
- Supply and demand for soil ameliorants
- Horticulture trials – poultry manure
- Nutrient balance study
- Horticulture trials - Mucuna
- Poultry manure extension
- Compost extension

Urban natural resources (lead researcher Mr. Adam)

- Individual resource studies
- Urban gaps study

Planning (lead researcher Dr. Williams)

- Peri-urban definition
- District policy-making and planning
- Incorporation of environmental issues into planning
- Analysis of information requirements for natural resources planning

Information system (KUMINFO GIS) (lead researcher Mrs. Pender)

- Establishment of the system (the Kuminfo GIS, the Kuminfo research metadatabase, the Kuminfo data catalogue)
- Advisory support, assistance and training in the use of Kuminfo
- Aerial digital photography
- District level planning

RESEARCH ACTIVITIES

General, land and livelihoods

The research activities for the land and livelihoods component can be divided into three main phases:

- the **inception phase**;
- **detailed research** into land and livelihoods-related issues;
- **development of strategies** to enhance land and livelihoods options for peri-urban inhabitants.

The research approach involved use of both qualitative and quantitative methods. Rural appraisal approaches were used to enable researchers to learn from local people about their means of livelihoods, use of natural resources, their perceptions of the effects of urbanisation and major issues of concern. Structured surveys were used to explore how prevalent specific factors were within the peri-urban area or particular villages. In the development of strategies, a participatory approach was taken with researchers and villagers in two villages working together to produce village plans and implement pilot projects. The research focused particularly on the issues affecting the poorer members of the communities. Factors such as gender, age and social status were taken into account throughout the implementation of the research.

The research team

A core team of researchers from UST and NRI was responsible for most of the studies. Other researchers contributed specialist studies and inputs (Table 2)

Table 2: Research team for the Land and Livelihoods component

Researcher	Organisation	Contributions to research
Core team		
Prof. K Kasanga	Project Co-ordinator, ILMAD, UST	Land tenure papers
Dr K Nsiah-Gyabaah	Project Lead Researcher BIRD, UST	Village rural appraisals and VCS co-ordination
H Warburton	NRI	Design & analysis – all studies
K Oppong-Nkrumah	ILMAD, UST	Field implementation, design, data input – Village rural appraisals, VCS, Household survey, Wealth Ranking, Family case studies, Community Groups, Homelessness, Participatory planning
E Fredua Antoh	BIRD, UST	Field implementation, design, gender specialist – Village rural appraisals, Stakeholder study, Wealth Ranking, Family case studies, Community Groups, Homelessness, Participatory planning
V Adu Gyamfi	College of Art, UST	Field implementation, design - Family case studies, Community Groups, Homelessness
F Amponsah	CEDEP	Village facilitator, Participatory planning
Other contributors		
M Adam	NRI	Village rural appraisals & VCS design, agricultural inputs
J Pender	NRI	Links to KUMINFO
S Floyd	NRI	Statistical analysis, VCS
H Baryeh	Lands Commission	Land tenure paper
Dr A Owusu-Bi	BIRD, UST	Village rural appraisals, VCS field implementation
P Sarfo-Mensah	BIRD, UST	Village rural appraisals & VCS field implementation
S Eduseh	BIRD, UST	Stakeholder study
A Mills	NRI	Database design – VCS & Household survey
Hannah Boakye	UST	Data entry - Household survey
Samuel Opoku S K Mpobi Agnes Boateng Emmanuel Botwey	UST	Enumerators - Household survey

The inception phase

During the inception phase the objectives of the research were to identify the main characteristics of the peri-urban area around Kumasi, the major issues concerned with use, access and control of natural resources and how these were affected by proximity to the growing urban centre of Kumasi. The studies undertaken during this phase are summarised in Table 3.

Table 3: Research activities in the Inception Phase

Study	Scope	Study type	Objectives
Village rural appraisals	6 selected villages	Participatory rural appraisal approach	To investigate:- Organisations & planning processes related to natural resources, Stakeholders involved in natural resources, Constraints in peri-urban agriculture, How the village is changing over time, Local perceptions of urbanisation
Village character-isation study	66 randomly selected villages within 40km of Kumasi	Village-level questionnaire with key informants	To investigate the main characteristics of peri-urban villages & their prevalence throughout the peri-urban area.
Specialist Studies			
1. Land Tenure Study	Focus on Kumasi & Asante traditional areas	Desk study	To describe national and local, government and traditional land tenure systems and their application in peri-urban areas.
2. Stake-holder Study	Peri-urban area	Mainly desk study	To identify main stakeholders from traditional and government sectors involved in natural resource management.

Village Rural Appraisals

This was the first major project field exercise and carried out during March and April 1997. The overall objective was to investigate and gain feedback from villagers on access, management and control of natural resources in peri-urban villages, and how these are affected by proximity to the urban centres.

The specific objectives were, at village level:

- To investigate the organisations involved in, and planning processes related to, natural resources;
- To investigate the stakeholders involved in access, control & management of land;
- To investigate the stakeholders involved in access, control and management of water, forest products, sand & stone;
- To assess constraints in peri-urban agriculture, particularly in soil fertility;
- To explore how the village is developing & how the population is changing over time;
- To learn from villagers about their own perceptions of urbanisation.

The NRI team commissioned 5 researchers from the University of Science and Technology (UST), under the guidance of Dr. K. Nsiah-Gyabaah, then Acting Director of the Bureau for Integrated Rural Development (BIRD) at UST as Lead Counterpart, to undertake the study.

The guidance notes and checklists for the field work of the study were prepared by the NRI team and pre-tested in the village of Apromase, Ejisu-Juaben district, by the joint NRI and UST team. The main field work in the six selected villages was carried out between 17th. March and 11th. April 1997. A first draft of the report from the UST team was discussed on the visit of the NRI team in May and a final draft from the UST team presented in June.

Village Selection

The criteria chosen for village selection were that, in order for the villages to be reasonably representative of the peri-urban interface area, the villages should:

- Be spread fairly evenly geographically around Kumasi and up to 40 km radius. This radius was selected as an initial estimate of the extent of direct[6] peri-urban influences and likely to contain variations in the extent of that influence.

[6] Direct influences are those where there may be competition for resources (land, labour) between agricultural and urban pursuits. Indirect influences such as Kumasi's market sphere of influence will extend further than 40 km.

- Include villages both on and off (more than 2km) main tar roads. Differences might be expected to occur due to differences in ease of access to transport and markets.

- Include villages with granite and villages with phyllite geology (in the ratio 4:2). The team conferred with a senior soil scientist, who suggested that there might be differences in farming systems and potential for development on the soils of the two principal geological formations of the Kumasi area.

- Have good potential to continue work in. The selection on the basis of this criterion was left to the field team to decide on. If there were local institutional problems within the village, this might hinder official sanction for the continuation of any project work.

The selected villages have the following characteristics with reference to the above criteria:

No.	Village	Radial distance from Kumasi	"On" main tar road	Geology
1	Duase	8 km	No	Granite
2	Abuakwa	10 km	Yes	Granite
3	Daku	10.5 km	No	Phyllite
4	Swedru	15 km	No	Granite
5	Nyameani	28 km	Yes	Phyllite
6	Domeabra	30 km	No	Granite

Two of the villages (1 and 2) had been included in initial field visits in the Kumasi baseline studies 1996 (Holland et al. 1996) and one (no.5) had been included in a horticultural survey in 1995 (Hall 1996). Visits to all villages prior to conducting the studies established that there were no apparent reasons to believe that these would not be suitable for continuing work.

Conduct of field work

A reconnaissance survey was first undertaken at each village for the team to familiarise themselves with the people, the traditional structure and the general view of communities. Traditional protocol was followed with the Chiefs and elders prior to scheduling the days on which the detailed rural appraisal would take place.

Two days were spent in each village. A participatory rural appraisal approach was used. Researchers discussed topics (using semi-structured interviews) with groups of villagers: Chief and elders, Queen Mother and women, young women, young men. Villagers also constructed maps of their village. Field visits were made with farmers from the village and soil samples collected for analysis. The components of the survey were:

1. Participatory mapping:

- ❖ To facilitate villagers mapping the features which they consider of importance in the village
- ❖ To investigate perceptions of the development process and changes in physical layout in the village over time

2. Discussion with Chief and elders group:

- ❖ History & development of village
- ❖ Control of and access to land, natural resources and services

3. Discussion with Queen Mother and women's group:

- ❖ Women's control of and access to resources and services
- ❖ Women's livelihoods
- ❖ Village development

4. Discussion with young men's group:

- ❖ Youths' control of and access to resources and services
- ❖ Youths' livelihoods
- ❖ Village development

5. Discussion with young women's group

- ❖ Youths' control of and access to resources and services
- ❖ Youths' livelihoods
- ❖ Village development

6. Discussions with farmers as a group and individually

- ❖ Identification of farming systems
- ❖ Identification of constraints, using problem ranking
- ❖ Investigation of soil fertility perceptions of farmers

7. Soil analysis (carried out by staff of Soils Research Institute)

The agriculturalist and the soil scientist carried out the last two components. The rest of the team acted as facilitators and recorders in the group interviews.

At the end of each day, enough time was allocated for discussions among the research team about findings, observations and views on the village. Attention was given to the differences in knowledge, perceptions and attitudes from the different groups and possible reasons for this. Notes were then compiled on the findings.

In order to characterise the soils of the villages, composite samples were taken from four of the farming systems identified to depths of 0-20 cm and 20-60 cm for laboratory analyses. A 60cm. deep minipit was then dug for each of the soils sampled and fully described in accordance with the FAO guidelines.

Village Characterisation Study

Studies around Kumasi have been focused on individual villages, and there is a dearth of information about how these individual studies relate to the peri-urban area as a whole, and how representative the villages are across the wider peri-urban area. The objective of the Village Characterisation Study was to determine the characteristics of peri-urban villages in terms of their natural resource management, community structures and relationships to Kumasi. This would help place village-based studies within the wider peri-urban setting and provide information at a village level for the project outputs.

Village selection

Sixty-six villages were selected from within a 40 km radius of Kumasi, using a stratified random design. The strata used were selected on the basis of access to the city:

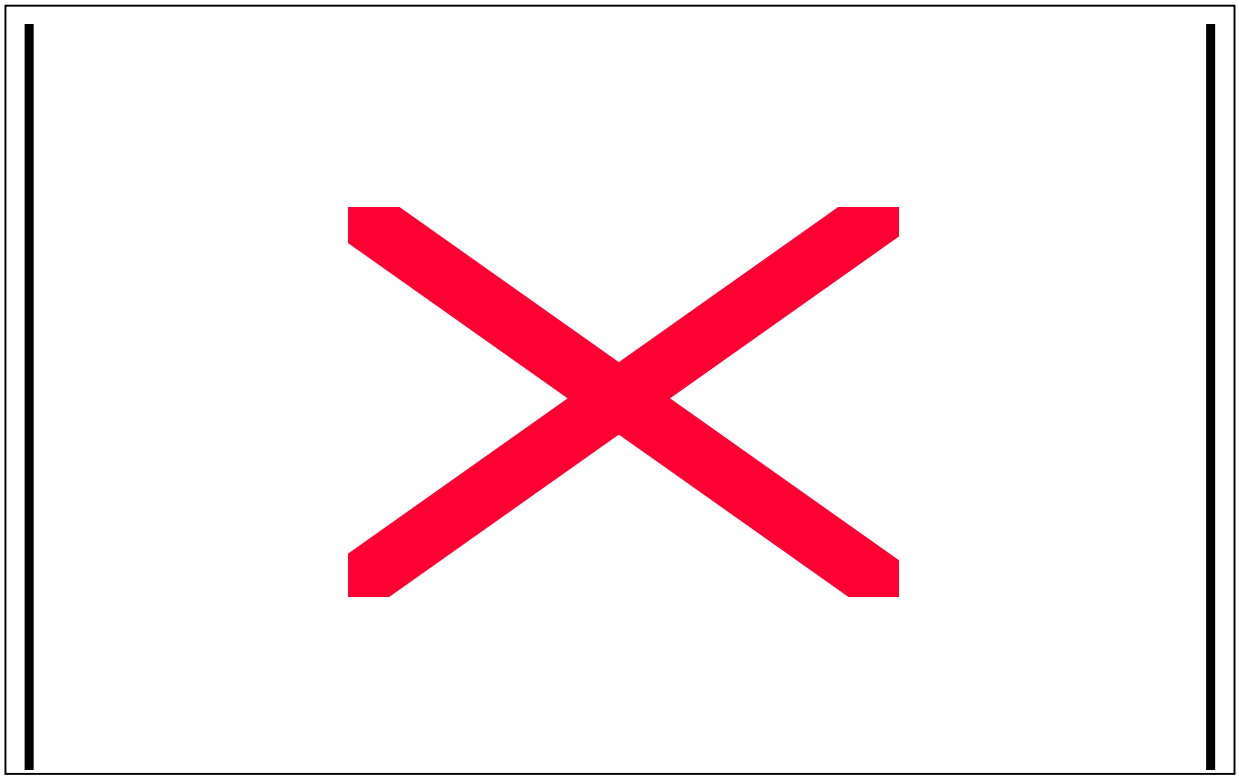
(a). On-road (closer than 2 km from main road)

(b). Off-road (more than 2 km from main roads as shown on 1:50,000 map)

(c). Within 5 km. of the city centre main market

Random selection within these zones was then made. Figure 2 shows the villages selected.

Figure 2 : Location of VCS villages.



The Questionnaire

Village-level structured questionnaires were designed to cover the following topics: village institutions, facilities, land use and tenure, land prices and farm rents, demography, employment, agriculture, commerce, environmental problems and major changes in the village. The questionnaire was pre-tested, then administered in the 66 villages by researchers helped by assistant enumerators. Key informants were interviewed within each village. These included Chiefs, Elders, Assembly men, other community leaders and additional informants. Women were always included as key informants in each village.

It should be emphasised that this is a village-level study and provides information about the availability of various facilities and characteristics of the village. It does not provide exact information on individual households or villagers' access to facilities. Since the data was gathered from key informants, it depends on their knowledge and perceptions, rather than on objectively verifiable information (such as actual population counts). Therefore the data must be interpreted with caution. Also time constraints meant that the number of key informants that could be interviewed in each village was limited. Information on each topic was sort from at least two different informants to provide a check on the responses. The information provided may therefore sometimes be *inaccurate* due to lack of knowledge on the

part of the key informants, or *biased* due to people having different perceptions of some issues (for example, views may vary considerably depending on the economic status or gender of the key informants).

The data from the VCS were entered into a database using the package Microsoft Access, initially at the Land Administration Research Centre at UST. On completion of the data entry, electronic files were imported for spatial analysis to the KUMINFO system in Kumasi and copies of the data taken to NRI in Chatham for statistical and spatial analysis.

Frequency tables, and cross-tabulations relating the response on many variables to the accessibility[7] to Kumasi were drawn up using the statistical package SPSS (Statistical Package for the Social Sciences).

Specialist Studies

The objective of these studies was to draw on local expertise to provide in-depth research on specific topics related to project outputs. This would complement the field studies undertaken by the project.

Land tenure study

(H I Baryeh)

The findings from the baseline studies (Holland et al. 1996) and the Village rural appraisals had highlighted the importance of the land tenure system in influencing (and being influenced by) the changes in land use and growth of housing. The aim of this study was to look in detail at the current land tenure arrangements in the peri-urban area, and how these relate to customary and legal arrangements. The study looked at differences between different types of land and ownership, and how these have changed over time.

The study included a review of existing literature on land tenure and management systems in Ghana generally and in peri-urban Kumasi in particular. It also drew on the results

[7] The cost of a trotro to Kumasi was used as a proxy for the accessibility of Kumasi. This was justified on the basis that there was a strong correlation between cost to Kumasi and distance from the city centre main market, but cost to Kumasi was felt to be a better proxy as distance was only measured as the crow flies and not in terms of the exact distance by road. Also, cost to Kumasi was strongly correlated with time to Kumasi, so it was unnecessary to use both of these measures as proxies for accessibility.

from a recent study on land tenure in peri-urban Kumasi based on case studies in six villages[8], and on the researcher's experience with the work of the Lands Commission.

Stakeholders involved in natural resource management

(S E Edusah and E Fredua Antoh)

This study was designed to look at the stakeholders involved in natural resource management and to analyse the trade-offs, conflicting and complementary interests between them. Case studies of the 6 villages used in the rural appraisal studies were used, and researchers also obtained information from interviews with district officials.

Detailed research phase

Results from the Inception phase had highlighted a number of issues and questions that required further research in order to assess the effects of urbanisation on natural resource management and on people's livelihoods. These included:

- The extent of land taken from farmers for housing, and the compensation paid;
- The proportion of people still engaged in farming and the importance of this to their livelihoods;
- The change in types of occupation amongst peri-urban inhabitants;
- The extent of homelessness in peri-urban villages;
- The roles and effectiveness of institutions including family structures, community-based groups, district and regional groups in peri-urban villages;
- Characteristics of the poorer, most vulnerable inhabitants of peri-urban villages;
- Strategies used by families and individuals to cope with the effects of urbanisation.

[8] Urbanization, Land Markets and Gender insecurity in Peri-urban Kumasi (Kasanga et al. 1997)

In order to address these questions, detailed studies were designed which focused on four selected villages. A summary of the studies is shown in Table 4.

Table 4: Research activities for phase 2: detailed research studies

Study	Scope	Study type	Objectives
Household survey	All households in the 4 villages	Structured questionnaire	To provide quantitative data on household structure, occupations, access to farmland, facilities, dependence on Kumasi
Wealth ranking study	All households in the 4 villages	Wealth ranking methodology with Key informants ranking each household	To investigate: People's perceptions of differences in wealth & reasons for this; Identify the poorer households in the villages; Assess the appropriateness of wealth ranking in a peri-urban environment.
Family case studies	Four families selected from different wealth categories in the 4 villages	In-depth semi-structured interviews with family members	To investigate how individual families have coped with urbanisation, the changes between generations, and their dependence on natural resources and on Kumasi
Community Groups Study	All village-based groups in the 4 villages with a recognised membership.	Interviews with group members of each group.	To identify the types of community-based groups, their membership, roles & effectiveness in village development.
Homelessness study	Homeless people in the 4 villages	Interviews with homeless people in the villages	To identify the extent of homelessness & the reasons for it.

Village selection

The four villages were selected to cover the range of village types identified in the Village Characterisation Study, i.e. Type I – urbanised, Type II – peri-urban, Type III – rural. The villages had all been included in some of the previous studies, so background information was already available on them. The villages selected were:

Apatrapa Type I – urbanised

Aburaso Type II – peri-urban

Duase Type II – peri-urban

Swedru Type III - rural

Household Survey

There was very limited secondary data available on villages in the peri-urban area. For example, the most recent population and occupation census dates from 1984 when economic conditions in Ghana were very different from the current situation. Therefore, in order to find out the current situation regarding population, household and occupation structure, and to investigate the prevalence of factors such as loss of agricultural land, a structured questionnaire survey was undertaken. The specific objectives were to provide:

- quantitative data on types of houses and household structure;
- quantitative data on individuals' access to resources and facilities, occupations, and job location;
- Specific information on access to farmland and any loss of farmland due to urbanisation.

The household survey consisted of a structured questionnaire designed to collect selected information on every house, household and individual in the four villages. The topics covered included information on the type of house, rooms, facilities available and number of households living in the house. For each individual member of a household information was collected on their gender, age, education, occupation, job location, years in the village, access to farmland, land taken for development.

The questionnaire was pre-tested then carried out by a team of four enumerators trained and supervised by Mr Oppong-Nkrumah (ILMAD, UST), from December 1997 to March 1998. The data was then entered into an Microsoft Access database for analysis. Information from 365 houses and 5,480 individuals was entered and checked. The data was analysed using SPSS software.

Wealth Ranking Study

One of the main concerns of the project was to ensure that the situation and concerns of the poorer and more vulnerable people within the community were understood and taken into account in any proposed development of strategies to enhance natural resource use planning. We also wanted to assess who benefited and who lost out during the process of urbanisation, and the reasons for this. The wealth ranking study was designed to find out

about local perceptions of wealth and poverty, and the relative wealth levels within the selected villages.[9] Specific objectives were:

- To find out what characteristics the local community use in judging relative wealth of individuals;
- To establish relative wealth of individuals within the community within several broad categories of wealth;
- To identify the poorest and most vulnerable in the community;
- To provide a basis for selection of households and individuals for case studies across the whole range of socio-economic spectrum.

Wealth ranking studies have often been used within small communities (less than 300 people). One further objective was to assess critically the usefulness and appropriateness of using the wealth ranking methodology in the peri-urban environment where village populations are usually growing and there are significant numbers of new inhabitants.

Methods

The names of household heads in the four villages were available from the Household survey, and these were transcribed on to separate pieces of card.

In each village, in conjunction with the village leaders, the team identified three key informants who were said to have an extensive knowledge of the village. The team requested that at least one woman was included in the three informants.

Each informant was interviewed separately, and the aims of the study explained. They were asked for their own ideas of wealth, and what makes someone better off than another. Their criteria were noted by the researchers.

The informants were asked to take the cards with the names of the household heads and arrange into groups of similar wealth. They could use as many or as few groups as they wished. Since there were a large number of cards, the informants were asked to take the cards

[9] It was not considered feasible to undertake a direct computation of income levels within the time and budget constraints, especially given the mix of occupations, subsistence and cash income, varying financial and other support from family members.

and complete sorting them during the next four days. A subsequent meeting was arranged with the researchers, and the ranking was reviewed and discussed. The researchers recorded the ranks assigned to each household and the descriptions given by the informants of each of their wealth categories.

This was repeated for the three informants in each of the four villages.

In addition to recording the wealth categories, the researchers noted any problems with the wealth ranking exercise, such as concerns over discussing wealth or embarrassment, denials that anyone has wealth, lack of knowledge of other people's wealth, leaving out outsiders such as migrants (for example, strangers who have bought plots, homeless).

The results of the wealth ranking exercise were analysed including the criteria given by informants for wealth and poverty. The ranking data was analysed for consistency across the different key informants, and the pattern of results between villages. An average wealth ranking score was calculated for each household.

Because wealth ranking is based on the subjective criteria of different individuals and each person used a varying number of wealth categories, it is not possible to make a direct comparison of wealth categories. Care needs to be taken in interpreting data based on qualitative criteria, using quantitative techniques. However, it is possible to gain information on the relative ranking of households in one village if their ranking is consistent across the three informants.

Family case studies

The family case studies were designed to follow up selected families within the four villages in order to learn from them about their means of livelihood and how households and individual family members had coped with increased urbanisation. Specific objectives were as follows:

- To find out how individuals' means of livelihoods has changed and why
- To find out who are losing their village farms, why and how they are compensated
- To find out how food self-sufficiency in changing in the peri-urban area
- To find out how individual and household access to land and other natural resources has changed
- To find out migration of family members in and out of the village

- To find out linkages between the individual, household and village structures and how these are changing
- To find out the extent of dependency on Kumasi
- To find out who gains from proximity to Kumasi and who loses out.

The case study families were selected using the results from the Household survey and Wealth ranking studies. The aim was to include a mix of male- and female-headed households, indigenous and immigrant families from a range of wealth categories. The households were grouped into the following categories, and then one household in each village was chosen randomly from each group[10]. In addition two households related to the royal families in Aburaso and Apatrapa were added, making a total of 14 households. The reason for selecting members of royal families was that their access to land might differ from other families, due to their relationship with the Chief who controlled the sale of land.

Table 5: Categories of Families Studied

Wealth Status	Stranger/ Male	Stranger/ Female	Indigene/ Male	Indigene/ Female
Rich	1	2	3	4
Poor	4	1	2	3
Very Poor	3	4	1	2

1. Apatrapa + Royal
2. Aburaso + Royal
3. Duase
4. Swedru.

Once the households were selected, the researchers identified the family[11] of the household head and interviewed the adult members of the family currently living within the village, starting with the oldest member of the family. A family tree was constructed for each family showing all family members including those who had left the village, and the

[10] The method of household selection was discussed with staff from the Reading University Statistical Services Group.

[11] The family here refers to the consanguinal line of the eldest person in the genealogy. This comprises the biological children of all members of the family and their dependants. Amongst the indigenous inhabitants and other Akan people, family is traced through the matrilineal line.

researchers used semi-structured interviews to guide their in-depth discussions with the resident family members.

Community-based Groups Study

The role of local institutions in village development and support to local inhabitants can be a crucial one in facilitating (or not) the access to information and resources and the pattern of development. Some initial information about community-based groups had been obtained through the village rural appraisals and characterisation survey. The aim of this study was to look in detail at the roles, membership and effectiveness of local groups within the selected villages, and to identify which had the potential to contribute to sustainable development and planning within the village. Specific objectives were to:

- Identify all the community-based groups in the village (formal and informal).
- For each group find out its role, membership rules, control and decision-making processes, access to resources, links with other institutions including government bodies and NGOs
- Identify particular interests in land use planning, agriculture and environmental issues, women, poverty alleviation
- Identify which group(s) (if any) with the capacity and interest to participate with the project in developing strategies for improvements in land use or in income-generating strategies.
- Provide recommendations as to how community groups could increase their effectiveness and incorporate environmental issues and equity issues into their agenda.

Researchers carried out the study in January 1999, first identifying the community-based groups through discussions with key informants in the village, then interviewing members and officials of each groups (such as the secretary and chairperson), using semi-structured interviews.

Homelessness Study

The homelessness study was undertaken to investigate a concern that had been raised by peri-urban inhabitants during the earlier studies. This was the perceived growth in homelessness, as well as landlessness, as one of the problems in peri-urban areas. This small

study was designed to investigate who was homeless and why, and what the concept of "homelessness" meant in the peri-urban area.

Through contacts in the village, researchers identified those people who did not have a room to sleep in. These people were interviewed and asked about their origins, why they were homeless, their means of support, access to resources and links with the village communities.

Land tenure studies

Research activities concerned with land tenure focused on two areas. The first area was to provide quantitative data on farms converted to housing development, and compensation processes in order to clarify and determine the importance of land tenure in the sustainable development of the peri-urban areas. The second area was to provide research papers, disseminate the findings to stakeholders including local inhabitants and policy-makers.

It was also intended to commission a UK consultant (Professor P McAuslan, Birkbeck College) to provide advice on legal and policy aspects, drawing on examples from other countries. Unfortunately, the consultant was not able to carry out the work, due to other commitments.

The provision of data on land lost from agriculture was undertaken as part of the Household survey (described below).

A number of papers covering land issues have been produced which have used data from the project. (Kasanga 1997, 1998, 1999, 2000, Warburton et al. 2000). Presentations were made at the Project review workshops in February 1999, the Project Final Workshop in February 2000. Due to the extent of the interest in land issues, participants at the final workshop also suggested a further meeting and presentation to members of the Asante Traditional Council in March 2000.

Development of land use and livelihoods strategies

Participatory land use planning

One of the major issues arising from the previous research work was the lack of participation by local people in future land use planning, despite the current developments having large impacts on their access to land and means of livelihood. The final phase of the project was based on findings from the earlier research work, and used mapping information developed with the KUMINFO system to develop participatory land use planning processes and pilot projects with villagers in two villages.

The objective of developing a participatory land use planning process was to enhance land use planning processes in the selected villages by:

- Increasing the participation of local stakeholders (such as poorer farmers and women) in planning decisions;
- Sustainable use of natural resources actively considered within the planning process
- Environmental issues considered within the planning process
- Inter-village, watershed and regional issues taken into account in village-level planning
- Linkages between the village and District and Regional planners and other professionals involved in natural resource management strengthened so that the villages can benefit from appropriate professional inputs.

The Participatory Land Use Planning (PLUP) was undertaken in two villages, Swedru and Aburaso, where the local communities were keen to participate in the research. The field research team consisted of K. Oppong-Nkrumah and Mrs E. Fredua Antoh from UST and F. Amponsah from CEDEP.

The activities were designed to facilitate a participatory planning process in the village, and, if agreed by the villagers, to lead on to initiate some practical strategy within the village aimed at more sustainable land use. Activities included the following:

Meetings were held with the chiefs and elders to discuss proposed planning process in selected villages (Swedru and Aburaso)

Maps of the villages were constructed from the aerial images and physical information held in the KUMINFO system. These large-scale maps were used by the villagers as a basis for marking and planning land use improvements.

Participation in the planning process was established through involving a number of different groups: Chief and elders, women, men, youth. Members of poorer groups were deliberately included, by using information from the wealth ranking study to identify poorer families.

Village boundaries were mapped out and transcribed on to the maps by the researcher and key informants walking the bounds and noting the locations.

Meetings were held separately with the different groups to discuss and map out natural resources and other features on to the base maps. Information included the following:

- Farm land divided into main agricultural uses
- Major differences in land characteristics (e.g. soil, drainage, slope)
- Forested areas
- Sacred groves
- Water sources, streams, irrigation, wells
- Roads, tracks and paths
- Residential areas
- Other built-up areas
- Waste dumps
- Latrines
- Sand winning sites
- Areas of environmental degradation, e.g. soil erosion, flooded areas

Once the mapping was completed, further meetings were held with the village groups to discuss and analyse the village maps and draw up a list of problem areas, opportunities and possible improvements. The groups determined their needs and priorities for land use improvement.

Meetings were conducted with District planners and other professional staff, such as Community Development staff to brief them on the project and invite them to take part.

District staff did accompany the researchers and take part in village meetings, but their other work commitments prevented much further involvement at village level.

Further meetings with all the village groups were held to pool ideas from the different groups, develop a participatory village plan and decide on improvements that were feasible and could be implemented by the villagers.

Depending on the land use planning priorities drawn up by the villagers, the researchers acted as facilitators in finding and bringing in technical experts as required to help advise villagers and providing a small amount of initial funds (£200). The villagers ran the projects themselves.

The mapping information provided by the villagers including the village boundaries and other features were digitised and entered into the KUMINFO system.

Further meetings were held with District planners to discuss the pilot projects in the two villages and how these fitted with their own planning procedures. The opportunities and constraints in participatory planning were discussed with recommendations for planning processes.

A report on the participatory planning process was compiled.

Strategies for income-generating activities

Information from the previous research studies were used to develop a report detailing the income-generating strategies adopted by peri-urban inhabitants, and recommendations for increasing the livelihood options available to local people (Warburton et al. 2000).

Workshops and dissemination

Workshops were held in February 1999 for researchers and for local inhabitants and planners. Findings from all aspects of the research studies (land and livelihoods, soil fertility, planning and GIS) were presented and future research plans discussed with participants.

The researchers' workshop 22-24th February 1999

Participants included local researchers from Kumasi, and District and Regional planners.

Farmers' workshop 25th February 1999

Participants were invited from the four villages included in the detailed research studies. The workshop was conducted throughout in the local language (Twi). Both researchers and villagers made presentations on findings from the research studies and major issues of concern in the peri-urban area. The workshop provided a forum for participants to air concerns about land and other issues, and to exchange information with those from other villages.

Folders containing information from the research studies, including maps generated from the KUMINFO system were given to the local authorities in each village (Chief or Unit Committee chairman).

Final workshop

This was held in February 2000. Representatives from the four villages were invited, together with researchers, District and Regional officials, Traditional Authorities, NGOs and policy makers.

One of the suggestions from the final project workshop was a further meeting with members of the Traditional Authorities to discuss the project findings, particularly those related to land tenure. Therefore a meeting was scheduled in March 2000 with the Asante Traditional Authorities. A one-day workshop is scheduled for April 2000, due to the concluding funeral ceremonies for the late Asantehene Otumfuo Opuku Ware II taking place during the second half of March.

Soil fertility

Waste stream products consultancy

In order to further the understanding of the potential and means for the project to become involved in research and dissemination activities into the use of waste stream products in peri-urban Kumasi, a consultancy input was commissioned from the Henry Doubleday Research Association which appointed Professor Philip Harris to carry out the work . The activities were set down in the terms of reference and carried out as follows:

Activity 1.1 From a review of the literature and personal experience, a description of materials available in peri-urban areas in general which have potential use as soil ameliorants, their characteristics and particular uses, was provided. These included organic (biologically derived, many of which are "waste" products of other production systems) and inorganic (non-biologically derived) products. Potential product flows were outlined.

Activity 1.2 Examples from other peri-urban/urban situations where such materials are being used, were given, with details such as:

- where do the materials come from?
- what type of organisation supplies them? e.g. individuals, public, private enterprises, NGOs etc.
- what type of farmers use them?
- why do they use them?
- what are the benefits or constraints in using them?
- what are the constraints in using these materials elsewhere?

A distinction was drawn between what materials have potential for use in Kumasi, and what materials are actually used in practice. Reasons why products are or are not used for soil amelioration were suggested, drawing on literature and experience in Kumasi and similar or contrasting peri-urban situations. Constraints to use which were considered included technical, economic and social factors.

Activity 1.3 The agronomic basis for comparison of the value of these products for "soil amelioration" was clarified and economic criteria on which to base comparison were suggested.

Activity 1.4 Advice on investigations to be carried out by the NRI agricultural economist was provided.

Activity 1.5 A written report was produced and discussions with the NRI economist were held.

Later activities of the consultant included:

Activity 2.1 Study and comment on the findings from the field work carried out by the NRI economist.

Activity 2.2 Advice on the methodology for analysis and presentation of the report of the NRI economist.

Supply and demand for soil ameliorants

Gaps in the information on availability and use/potential use of soil ameliorants and areas where further investigation was required were identified from the Henry Doubleday report (section before this) and discussions with Professor P.J.C. Harris. Areas which required particular attention were the quantities of the different soil ameliorant resources available and the soil fertility values of the materials.

An NRI economist, Ms. Heather Kindness, spent two weeks in September 1998 in the Kumasi peri-urban area. Information was collected from key informants and collated from relevant documents. Further information was collected (by Dr Joseph Famiyeh and an enumerator) from October 1998 to September 1999. The terms of reference for the study included the list of activities which were carried out:

1.1 Interview key informants and access data on the availability of organic and inorganic resources with the potential to increase soil fertility

1.2 Derive estimates of the quantities of nutrients available from these sources of supply

1.3 Compile an inventory of soil improvement resources for the greater Kumasi city region

2.1 Interview key informants, access data and estimate the present use of the inventorised resources

2.2 Collect data on potential future use of these resources

2.3 Compile a report on the present and potential uses of locally available soil improvement products

Horticulture trials – poultry manure

These were adaptive researcher-led verification trials on the effects of the use of organic as opposed to inorganic (mineral) manures with regard to agronomic and economic yield in the peri-urban situation and disseminate results to potential beneficiaries. The null hypotheses were:

1. The use of poultry manure gives an agronomically unacceptable and economically negative result.

2. There are no differences in the effects of poultry manure and inorganic fertiliser.

The trials were of two types : on-station researcher managed plus on-farm researcher-managed with farmer collaboration in field operations, recording and assessment of results. Ministry of Agriculture extension staff provided continuity and back-up advice for the on-farm trials. Farmer selection was by means of a special participatory rural appraisal was undertaken (Sarfo-Mensah 1997) with 31 vegetable farmers in three villages and the farmers were asked to select amongst their number those on whose fields they would prefer the trials to be run.

Treatments

1 No fertiliser application

2 Poultry manure basal application, at recommended rates (Sinnadurai 1992), 8 tonnes / ha

3 Inorganic fertiliser basal plus top dressing at recommended rates, 400 kg / ha 15:15:15 basal plus 240 kg / ha sulphate of ammonia

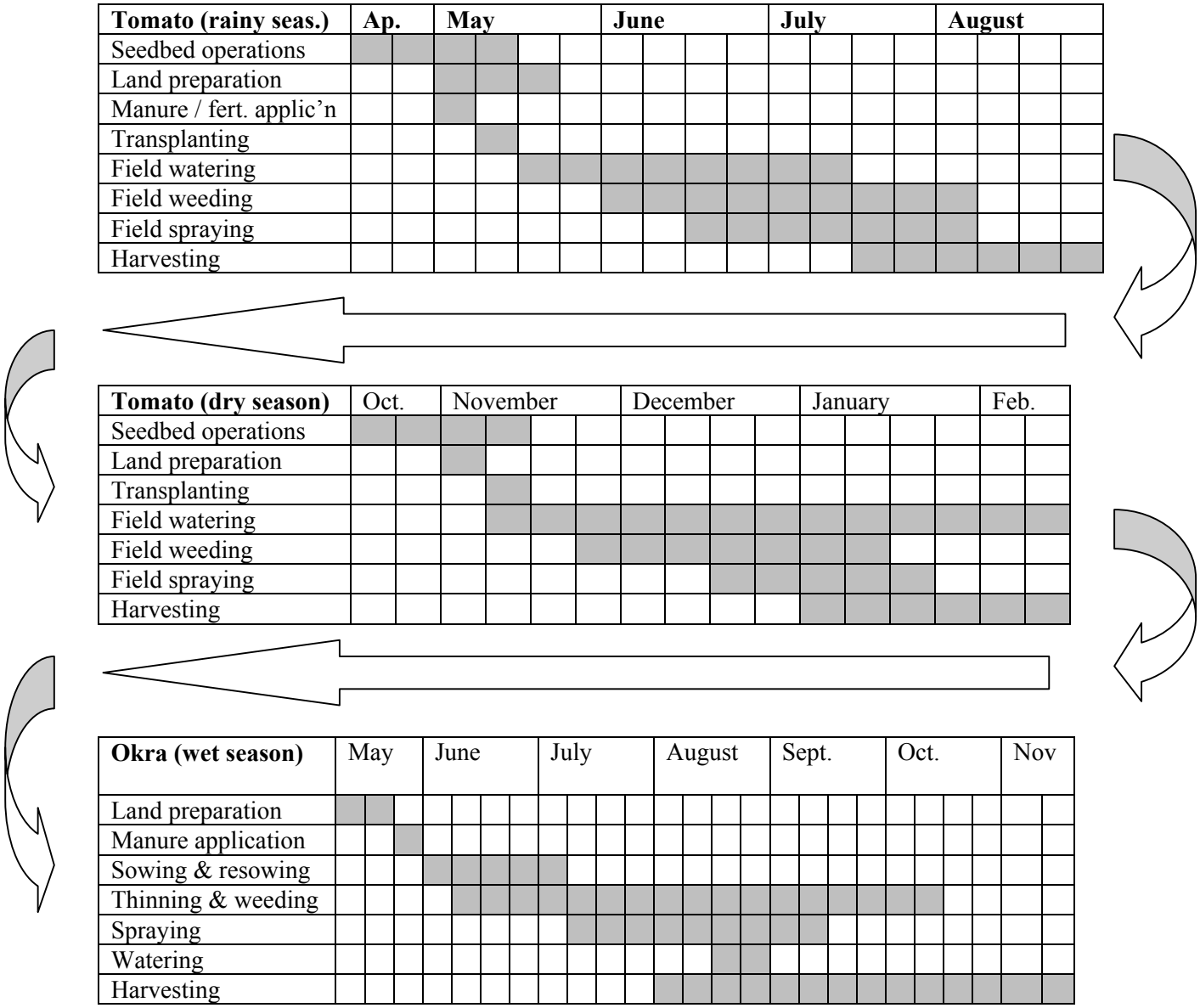
Both poultry manure and inorganic fertiliser at half recommended rates

The design was a randomised block with three replicates (blocks) in the on-station trials at the UST Horticulture Department station. Each plot was 8m x 12.5m (0.01ha). For the on-farm trials each farmer was allocated one replicate of the randomised complete block design with one each of the treatments described above. Each plot was 10m x 10m (0.01ha).

In the first, rainy, season trials were established both on-station (Department of Horticulture, UST, Kumasi) and on -farm (2 farms each at Duasi, Apatrapa and Darko) and these were continued in the second, dry season. Unfortunately the agricultural economist collaborator suffered a stroke and as a result the on-farm data for that season is unrecoverable.

In the third, rainy, season the trials continued only on the station. The crops in the first two seasons were tomatoes and in the third okra. Figure 3 shows the sequence of activities.

Figure 3: Operations on on-station plots, horticulture / poultry manure trials.



This plot was also used for the full duration of the nutrient balance study.

The on-farm trials were run in co-operation with the Ministry of Agriculture, whose front-line staff made regular visits and organised field days at critical stages of operations.

Nutrient balance study

The objective of this study was to establish the nutrient balance for N, P and K under the treatments studied both on-station and on-farm over several seasons' cropping. The trials

were carried out on-station and on-farm using the same plots used for the horticulture trials on poultry manure. Site characterisation consisted of a brief description of the soils at the experimental sites and chemical and physical analyses of composite samples. The treatments were thus as described in the previous section, and the design as above, consisting of four treatments in a randomised complete block design (RCBD) with three replications for the on-station trials and five replications (each farmer as a replicate) for the on-farm experiments. In each case the plot size was 100m2.

Initial and end of experimentation soil samples were analysed for various chemical and physical constituents. Samples were taken from two depths – 0-15 and 15-30 cm, within the crop ridges. The mineral fertiliser (15-15-15 NPK and sulphate of ammonia) and poultry manure were also analysed to ascertain their nutrient contents. In order to assess nutrient uptake, tomato plant samples (fruits and shoot) taken during the period of experimentation were analysed. Soil pH was measured in water at a 1:2.5 soil/water ratio. Organic carbon (Org. C) was determined by Walkley and Black wet oxidation method (Nelson and Sommers, 1982). Percent organic matter (OM) was calculated by multiplying organic carbon by the Van Bemmelen factor of 1.724. Total nitrogen (total N) was determined by the macro Kjeldahl method. Available phosphorus (Avail. P) was determined by the Bray P1 method. Exchangeable cations (Ca, Mg, K and Na) were determined after extraction with normal ammonium acetate solution; Ca and Mg in solution were determined by EDTA titration and K and Na by flame photometry. Effective cation exchange capacity (ECEC) was calculated by the sum of the exchangeable bases (Ca, Mg, K, Na) and exchangeable Al and H.

The nutrient reserves of the experimental sites were estimated for N, P and K. following the calculations outlined below by Defoer et al. (1998).

Estimated Nitrogen Reserves in the rooting zone

Rooting depth	=	20 cm
Assume Nitrogen content of soil	=	0.1 %
1 litre of sandy soils weigh	=	1.5 kg
The volume of 1 ha soil 20 cm deep	=	10000 m2 x 0.2 m
	=	2000 m3
	or =	2000 x 1000 litres = 2000000
	=	2000000 l
The weight of the soil	=	2000000 x 1.5 = 3000000 kg.

If 0.1% of the soil is made up of nitrogen, this gives 3000000 x 0.1/100 = 3000 kg N.

This amount represents the total reserves of N in the soil. Of this 1500 kg (50%) represents the "dynamic reserve". Only 1% of this is directly available for crop production

and subject to losses.

Phosphorus and potassium reserves in the rooting zone were derived from similar calculations.

The nutrient balance was then constructed considering two issues:

1. Identification of inputs and outputs, and
2. Quantification of the inputs and outputs.

The input consisted of mineral fertiliser and poultry manure and the output comprised the harvested fruits and shoot (stem and leaves). Farmers in the operational villages remove the latter from their fields.

As a general caveat, it must be pointed out that nutrient budgets are most useful when developed over time and trends are likely to be more important than a single 'snapshot in time' (Syers, 1995). Hence the three seasons' work here recorded would need to be continued to give further and more meaningful information.

Horticulture trials – Mucuna

The objective of this study was to determine the effects of Mucuna (Mucuna pruriens var. utilis) and mulch management on the yield of dry season tomato. Although the ability of mulch to conserve soil moisture and maintain temperature is well documented, the technology has not been adequately tested on-farm especially for dry season vegetable crop production, an important source of income for farmers living in the urban and peri-urban areas in Ghana. The trials were initially run in 1998-9 and in the second year additional treatments, using the Mucuna as a green manure, were included, partly to reflect similar trials taking place under NRI / MoFA auspices in Brong Ahafo under the DFID-sponsored Integrated Food Crop Systems Project.

Experiments were conducted on-farm in 1998 with four participating farmers at three villages in the Kumasi peri-urban area. The experimental design was a split plot with one replication per farmer. Within each replication the plot design was an incomplete 2x2x3 factorial. The division of the main plot was by type of fallow (Mucuna or grass) and of the subplots by mulch and fertiliser management system. Each treatment plot was 5.4m x 5m. There were three factors under investigation

- Fallow material (Mucuna / grass);

- Fertiliser / no fertiliser; and
- Mulch / burn, with an additional treatment for the Mucuna : zero-till in situ mulch. This was not used for the grass fallow as it was considered that the treatment would give a minimal yield.

In the second year, seven new farmers participated in the trial program. All the farmers established a field of Mucuna measuring 20m x 10m. The experimental design was similar to that of the 1998 trial except that in addition to the fertiliser factor the other subplot treatments were as follows:

- Mucuna residue incorporated (green manure)
- Mucuna residue left as surface mulch without tillage (zero tillage)
- Grass used as residual mulch after ridging
- Grass burned and ridged (farmer practice)

Also in the second year, two farmers who participated in the trial in 1998-9 also set up their own test plots to assess the effect of mulching on yield of dry season garden eggs and sweet pepper respectively.

The cropping sequence was as shown in figure 4.

Figure 4 : Sequence of cropping with on-farm mucuna trials.

	1998								**1999**												**00**	
Seasons ⟶	major rains					min. rain			dry			major rains						min. rain			dry		
Green maize crop																							
Mucuna																							
Slashing & land																							
Tomato crop																							

Nodulation of the Mucuna was profuse, with the presence of leg-haemaglobin at all sites. In the zero-tillage treatments the tomato crop was planted directly into spaces in the Mucuna cleared by creating openings by hand. Apart from the mucuna operations, all other cultural practices were as practised by the farmers.

Data recorded include plant establishment, assessment of fallow biomass, weeds, soil moisture and fractional light interception.

The quantity of biomass was assessed by cutting all plant residues from four random areas/fallow field before land preparation in November. Soil samples for nutrient analysis were taken at a depth of 0-15cm on the ridges and furrows immediately after land preparation in November. Soil temperature and moisture content were measured at tomato flowering stage, which was about the time that the crop was experiencing most stress.

Ministry of Agriculture front-line extension staff were involved throughout and two field days, one in each December 1998 and 1999, were organised at Darko village. The first was to demonstrate the beneficial effects of no burning and Mucuna to farmers. In all 25 farmers from Darko and other villages attended the field day. Activities of the field day were covered on a video cassette. The second was to demonstrate the effect of mulching and Mucuna on the growth and yield of tomato. 14 farmers from Darko and surrounding villages attended, also five Extension officers, researchers and a representative from GTZ.

Poultry manure extension

On-station and on-farm trials in 1998 and 1999 (see outputs from "horticulture trials – poultry manure") confirmed that the locally available poultry manure is able to provide for good vegetable crop yields at a cheaper cost than inorganic fertilisers. Following this work, an extension guideline summary was produced and the Ministry of Agriculture in the Kumasi urban and peri-urban area of the Ashanti region was approached to consider the possibilities of conducting an extension campaign based on the findings of the research.

The extension campaign was conducted in five phases, namely:

1. Familiarisation and training of the extension staff: April / May 1999.
2. Launching of the campaign : May 1999
3. Implementation of the campaign : June – August 1999
4. Review of results and follow-up : September / October 1999
5. Preparation of reports : November 1999 – January 2000

The MoFA Regional Director of Agriculture selected a senior officer at the Regional Ministry of Agriculture (Mr. Seth Osei-Akoto, the Regional Crops Specialist, RCS) as the principal collaborator in the project. He in turn enlisted some of the front-line extension staff (AEA's) in Kumasi Metropolitan Assembly (KMA) and the contiguous districts of Kwabre, Bosumtwe-Atwima-Kwanwoma (BAK) and Atwima into the project. The RCS was first given, as extension guidelines, a summary of the results of the KNRMP and other trials and provisional recommendations for the use of poultry manure.

A one-day training session was then held for 49 technical personnel of the Ministry of Agriculture, of which 25 were AEA's and the rest were senior officers or support staff. The resource persons for the training were KNRMP collaborators Drs. Nsiah-Gyabaah (Lead

Counterpart), Quansah (Soil Scientist) and P. Boateng (Horticulturalist). Correct practical techniques for application were demonstrated on a plot near the MoFA regional office at Cadbury Hall, Kumasi. Following the training session a MoFA / KNRMP fact sheet was produced and distributed to 350 AEA's, farmers and the general public. This refined and provided in a more appropriate form the information on application methods and rates. The MoFA video unit filmed the occasion.

Guidelines for the conduct of the campaign, the extension methodology and report formats were provided by the KNRMP NRI Agriculturalist, Mr. Adam.

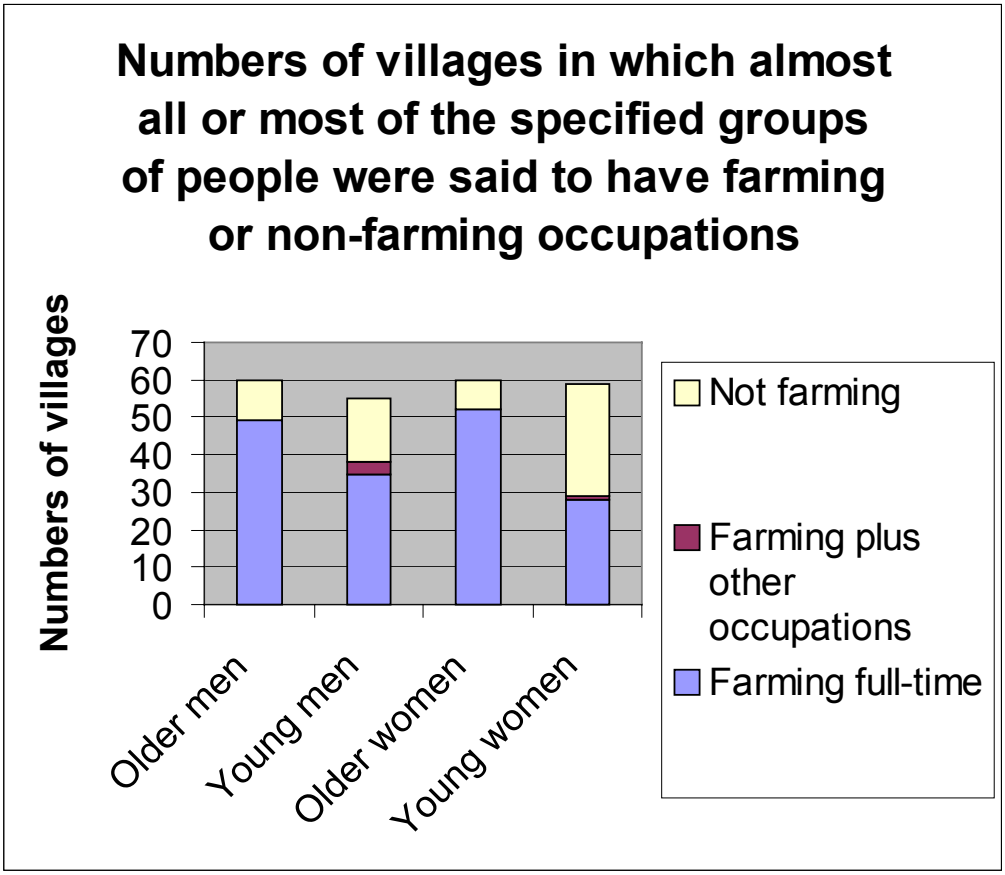
A total of 106 meetings were recorded by the AEA's. Attendance at these is summarised in Table 6 below and reflects the fact that it has often been mentioned to project research staff that the extension service tends not to reach an appropriate proportion of women.

TABLE 6. Attendance at campaign meetings

District	**No. of meetings**	**Total attendance**	**Of which**	
			Male	Female
BAK	19	232	163	69
Kwabre	61	1008	577	431
Atwima	12	172	126	46
KMA	14	170	109	61
ALL	106	1582	975	607
All, %'s			62	38

The village characterisation study (VCS), carried out in 66 peri-urban villages in 1997, would suggest that in peri-urban villages men and women are approximately equally dependent on farming, with older people, and especially women, more dependent; however, young women would seem to be generally less dependent than young men on farming. Figure illustrates this point.

Figure 5 . Dependence on farming in peri-urban villages.



At the initial meetings farmers were recruited to actively participate in the trial – demonstration programme. The extensionists in the KMA area were most active in this recruitment. In all districts the majority of farmers recruited were men and this was particularly. A high proportion of selected farmers, particularly in KMA district, had previous experience of using PM. This may be due to greater availability and/or awareness of the benefits of PM in this area, in particular by those growing seed maize at Assuyeboa.

Following the initial training, the RCS was invited by a local FM station (Otec) for an hour's radio programme to present the subject matter. By the end of the programme ten telephone calls had been received requesting expatiation, clarification and promotion of the technology.

19 AEA's were actively involved in the campaign. Training sessions to demonstrate the correct rates of application and methods were carried out by the AEA's with farmers in all targeted districts. At each village actively involved the AEA arranged for loading and delivery of PM from a nearby poultry farm to the most convenient site for the farmers to load onwards

to their plots. The procurement costs of this initial load were borne by the project. Meetings to assess farmers' knowledge, attitudes, skills and aspirations (KASA) with regard to PM were held by all AEA's.

The review of results, follow-up and findings presented in the report are summarised in the Outputs chapter.

Compost extension

In the inception phase of the KNRMP it was found, through the participatory rural appraisals (PRA's) and village characterisation survey (VCS) that whilst there is an increasing use of chicken manure from the large number of poultry farms in the peri-urban area, very little other organic waste is recycled and nearly all the municipal waste is dumped without any recovery of its potential soil ameliorant value. Very few farmers had even heard about composting and none were found who had actually practised it. These findings were reinforced by those of the study on supply and demand for soil ameliorants reported in the Outputs chapter of this report.

Following the recommendations of the waste stream products consultancy (see also in the Outputs chapter of this report), it was decided to work with an NGO in a peri-urban village. This option was chosen because the first two options suggested by the consultants were not feasible – the KMA have not installed a compost plant and the emphasis on higher-income suggested for the second option does not accord with DFID's poverty focus.

To complement the extension work with the MoFA, and introduce farmers to the idea of the recycling of nutrients in organic form, a project was therefore initiated through the leadership of the Ghana Organic Agriculture Network (GOAN) to familiarise and promote the making and use of compost in one peri-urban village. The general objective was to facilitate the promotion of composting in peri-urban agriculture among farmers and front line staff of MoFA, focussing on the community of Duase.

The Natural Resources Institute (NRI) agriculturalist, Martin Adam, approached the GOAN general secretary, Emmanuel Antwi, in April 1999, and a contract was drawn up. The principal features of the contract were as follows.

A participatory approach to training will be taken and practical training in the preparation of compost will be included. Local farm and household wastes, and/or other farm and community derived organic waste products, including poultry manure, black soil and sawdust will be used as the base materials. Both pit and heap composting methods will be

explained to farmers and the choice of method left to them.

To this end, the project will support the activities of GOAN staff including a facilitator (Mr. Ben Kusi Appiah) in working with the villagers of Duase.

Extension literature on composting with graphics and pictures for easy reading and understanding to enhance adoption of the technology will be produced.

Information about the appropriateness and extent of uptake of the methods promoted will be monitored, collated and evaluated with the participating farmers. It is also the intention that government agricultural extension officers and staff from research institutes with whom GOAN are linked will be involved with the evaluation.

Specific aims and activities will include:

(1) Target group: 25 farmers and 5 extension staff to be trained at Duase near Buokrom, Kumasi in three one-day workshops. Three extensionists to attend the weekly or fortnightly farmers' meetings with the facilitator.

Composting groups (5 groups) to work on a communal site composting with each group building one compost heap.

Each farmer will be expected to do his/her own composting on farm.

This will give the farmers the opportunity for comparison.

At weekly meetings, participants will examine communal compost heaps and make their independent assessments.

Each group will then visits individual group member's farm-compost heap & report back to the General/communal compost meeting on the following week.

When compost is ready each farmer will be encouraged to try the compost on vegetables and compare it with chemical fertiliser & traditional methods for at least two farming seasons on the same piece of land.

Group monitoring & assessment will be a major feature where the old groups will be reshuffled to form new groups to monitor & assess the impact, cost effectiveness and other benefits of using compost.

A fortnightly meeting will be on-going where the farmers will have the chance of visiting others' farms and submit findings problems/and/ or observations to general discussion in at the following meeting.

The facilitator as well as the MOFA extension staff will be visiting the individual farmers at their farms, providing necessary technical support/advice.

The facilitator will produce a monthly progress report (on a form to be provides) to the GOAN Secretariat.

A quarterly report will be submitted to NRI/KNRMP co-ordinator.

(13) KNRMP Team, GOAN technical team, Farmers, CRI, SRI and MOFA officials will evaluate the project at the end of the first year.

(14) A final report will be produced by GOAN at the end of the project.

The facilitator, who is a farmer from Offinso, some 20 kilometres north of Kumasi, had received training in composting and organic agriculture on a course run under the auspices of the Ministry of Agriculture. He commenced his visits to Duase in May 1999. His regular monthly reports have included a diary of activities; a summary of his diary up until the end of 1999 follows (Table 7). The activities will cease to be funded at the end of March 2000.

Table 7: Diary of activities of GOAN facilitator, May – December 1999.

Month	Group work		Individual work		Other work	
	Type	Att.	Type	Att.	Type	Att.
May	Workshop, selection	42	Visits	8	Letter to chief	
June	Starting compost	25				
July	Turning compost	17-25	Visits	17	Video showing	30
Aug.	Turning, land prep'n	25-33	Visits	5	Video filming	33
Sept.	Compost application	24	Visits	8-18	Trip to demo. farm	12
Oct.	Turning & inspections	18-25	Visits	10		
Nov.	Turning & inspections	30	Visits	25	Photo. taking	30
Dec	Turning & inspections	15-30	Visits	10	Farmers' day	25

Urban natural resources

Individual resource studies

The purpose of this work was to describe the extent and type of natural resource production systems within the Kumasi Metropolitan Assembly (KMA) area and assess their significance as providers of livelihoods and livelihood opportunities for urban dwellers. To this end, the project enlisted eight UST students to carry out the studies in partial fulfilment of their academic requirements. The students were supervised by UST researchers who have been collaborators with the KNRMP.

In discussions amongst the research team members, eight natural resource production systems were selected for study. These were:

- Cattle production;
- Sheep and goats production;
- Pig production;
- Poultry production;
- Small animals production;
- Aquaculture (fish farming);
- Backyard crop production; and
- Fuelwood gathering and utilisation.

Outline terms of reference for the studies were prepared by the researchers and the types of data required to be collected and analysed indicated to the students, under the general headings of:

a. an assessment of the socio-economic characteristics of urban farmers (including demography and livelihood systems);

b. description and explanation of inputs and outputs (including husbandry systems, types of output and markets for both animals and crops); and

c. review of proposals for improving the productivity of the systems (including constraints to production, farmers' future plans and assessment of the environmental impact of the production systems).

Sample surveys, using questionnaires and checklists for structured discussions, were

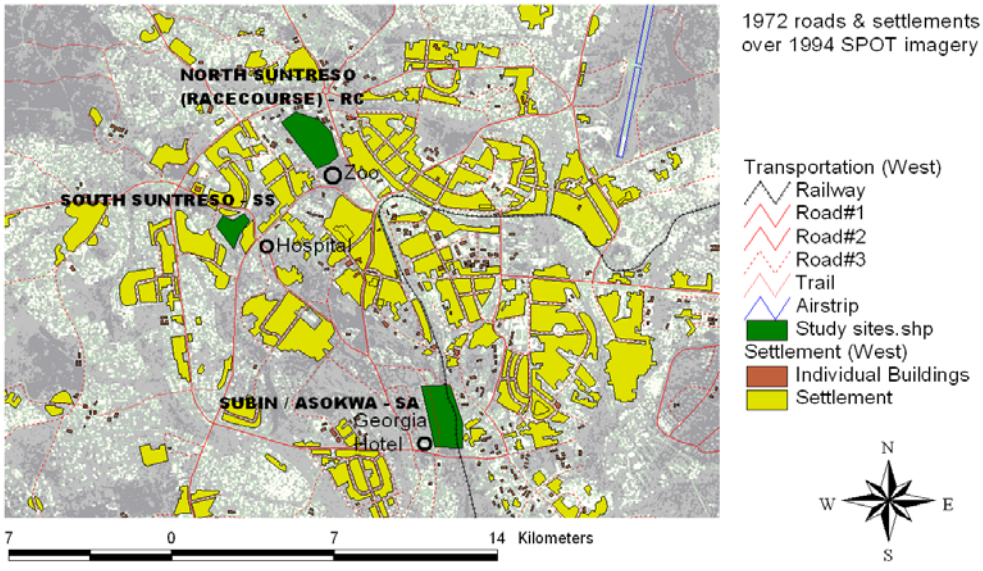
carried out by the students with respondents selected by themselves. For the backyard crop production study a sample frame stratification according to housing density and type was provided but the other students had to select their own samples and some used an element of stratification by size of producer's enterprise. This they did by reference to the limited information available at government offices and using local knowledge of the city.

Urban gaps study

This was carried out by P. Kumordzie, a student at the Institute for Renewable Natural Resources at UST Kumasi, under the supervision of Mrs. Olivia Agbenyega, a socio-economist at the same institute. The purpose was to collect data which provides adequate and reliable information for understanding the Kumasi city 'urban gaps' crop production system, which is mainly carried out in valley bottoms. This is in order to make recommendations for management, improvement and development in the study area as well as related urban areas. Three areas of open land in the central city area of Kumasi were selected as being sited in different density housing areas. 59 plot cultivators were interviewed and responded to answers to a prepared questionnaire. The areas of the plots were outlined in the field on aerial photograph imagery. The questionnaire and geographical data were made available to a GIS system based in Kumasi and NRI.

The three areas were South Suntreso, Subin / Asokwa and North Suntreso (Racecourse). Their location is shown in figure 6.

Figure 6. Location of urban gaps study sites.



Planning

Peri-urban definition

A brief study was commissioned in 1997 from A. Edmundson (Land Administration Research Centre, UST) to help identify the Greater Kumasi city-region using various simple indicators. Rees (1992) defined the "ecological footprint" of the city as the total area of land required to sustain a city and this study was intended to provide some geographical delineation of the extent of Kumasi's urban footprint. The following indicators were used:-

- Villages visited by Kumasi market traders on daily basis.
- Villages which depended on Kumasi for their daily needs of meat, fish, perishable farm produce imported items and health services.
- Areas supplying perishable foodstuffs to the Kumasi market, and
- Daily commuting zone for employment and other services in Kumasi

Tro-tro (minibus) operators were interviewed to determine the number of vehicles per day travelling to outlying towns and villages. Information was also obtained from market queens or traders on the villages visited by the Kumasi daily traders on a daily basis.

A second short study was carried out in 1999 in order to gain some quantitative indication of the direction of spread of Kumasi's influence and help identify where development pressures are taking place. To this end, a pilot survey was conducted of trotro movements on representative days on 12 routes around Kumasi. The number of journeys made by each vehicle on the day of the survey, its departure or arrival time, and the time spent waiting at the trotro station, and the numbers of passengers joining or leaving each vehicle were enumerated. The 1693 vehicles travelling to and from Kumasi have been entered into a database, and maps showing the hourly flows of vehicles into and out of the city have been prepared using KUMINFO. A sample of 882 passengers waiting to join vehicles to Kumasi were interviewed to find out their age, sex, the purpose of their journey, the frequency of similar journeys to Kumasi, and the distance from their home to the trotro station.

District policy making and planning

An analysis of current planning processes and constraints in the Greater Kumasi City

Region was conducted in 1997 by a team from the Department of Planning, University of Science and Technology, Kumasi, led by Dr. J. Kokor. Community participation was a major requirement in the preparation of the 1996-2000 Medium Term District Development Plans, therefore this study focused on the different inputs from the community and contrasting roles played by assembly members. For each district, they summarised the problems and constraints in the plans for key natural resource and environmental issues, and outlined the proposals to deal with them. They also reviewed the procedures adopted by the Regional Planning Co-ordinating Unit of the Ashanti Regional Council to harmonise the district development plans in the region, including environmental problems and constraints and the recommendations by the RCC on each district's proposals related to natural resources and environmental management. Interviews in the Ashanti Regional Office of the Environmental Protection Agency were used to outline the predominant environmental problems encountered, the consultations taking place, and the limited number of environmental impact assessments and environmental action plans by firms for the management of existing environmental problems. Interviews enabled the team to identify the relationships between the district physical planners and the Ashanti Region Town and Country Planning Office. Each of the five districts was visited to inspect and list the layout plans prepared in each district. Finally, the key actors in the planning process, their roles and concerns were identified, and suggestions offered on how the participatory planning process can emphasise the natural resources and environmental aspects which were found to have received little attention in the district development plans.

Following the report of this study (in Volume 2 of the Inception report) more detailed summaries of the 1996-2000 Medium Term District Development Plans were prepared by the project regional planner (Dr. Keith Williams). The reports included critical reviews of the methodologies adopted by the district assembly consultants who had prepared the plan. These were circulated to each of the district development planners prior to a Workshop in August 1999.

The third component of the research into the district planning processes was a survey undertaken by Stephen Buabeng, the development planning counterpart at BIRD, UST in each of the five districts into the composition, functions and responsibilities of the committees and sub-committees concerned with planning and environmental issues. These interviews were set into a wider context with a review of the new decentralised planning system in Ghana in which district assemblies form the basic unit of government administration. At the village scale, he also identified a sample of 30 active Unit Committees, which were visited to conduct interviews to determine each unit committee's development priorities and their current activities. Investigations were also conducted within each of the districts to find out whether any Community Environmental Committees have been established, as proposed in the

Guidelines on Environmental Management for District Assemblies, prepared in 1992 by the Environmental Protection Council. Interviews elicited reasons for the failure to fully implement the EPC proposals for Environmental Management Sub-Committees, and for the absence of any Community Environmental Committees in the Kumasi City Region. Interviews were conducted with appropriate district officers to identify the limited numbers of environmental non-governmental organisations currently operating within the Kumasi City Region.

Other research activities included a review of the National Environmental Sanitation Policy paper, prepared by the Ministry of Local Government and Rural Development in 1999, and its significant implications for planning for the environment in the district/metropolitan assemblies and unit committees.

Incorporation of environmental issues into planning

Throughout the process of interaction with the district planners in the Kumasi City Region, it has been argued that the allocation of resources, remedial or conservation measures, etc., to villages or towns within a district can be facilitated by maps showing where greatest needs exist, or where future development pressures are expected. It has been demonstrated that when linked to a Geographical Information System like KUMINFO, complex information can be readily displayed at different scales, simply, quickly, and cheaply, appreciated by both untrained community members or trained professional planners, and used to stimulate discussion on the environmental and other implications of alternative development scenarios within the district or the city region.

Analyses of recent spatial planning classification in the Kumasi city-region have enabled the pointing out of flaws and weaknesses in these techniques. Various project workshops conducted with the district and regional planners and environmental specialists have drawn on the results of these analyses. Suggestions have been made for the adoption of a common methodology for environmental and other problems as a result of the anticipated inevitable future sprawl of the built-up area of Kumasi.

Pilot participatory land use planning exercises were conducted in Swedru (Kwabre District) and Aburaso (KMA). This involved using digital air photographs to produce accurate base maps for land use planning, in which community members were actively involved.

Analysis of information requirements for natural resource planning

The district assemblies have been given the responsibility for planning and environmental management. They are expected to develop linkages and work together with both the regional level of government as well as their subordinate or sub-district levels of administration, the Area Councils and Unit Committees. All levels of government are expected to actively involve community members in their deliberations. The district assemblies are also expected to engage in public-private partnerships with the private commercial and voluntary sectors. As such, the district assembly becomes the key to the involvement of all stakeholders. Attention has therefore been concentrated on the information requirements of the district assembly planners.

A series of Workshops was held to obtain the opinions of Ghanaian planners on the gaps in information needed for planning and environmental management. These were attended by all peri-urban district development planners, all district town and country planning officers, together with representatives of the Ashanti Regional Co-ordinating Council, the Ashanti Regional Office of the Environmental Protection Agency, and the Ashanti Regional Office of the Town and Country Planning Department. To supplement the findings of the workshops, a survey was conducted by the regional planning counterpart into the information gaps existing for each of seven Sub-committees in a representative District Assembly (Kwabre).

Further Workshops were held to demonstrate how databases and computer maps could be used for improved planning. Selected results from the Village Characterisation Survey were displayed in a Workshop for the planners in September, 1998, to demonstrate the practical applications of the maps produced by KUMINFO. These computer maps motivated the district planners to extend this work and they agreed to supply information for all recognised communities (towns and villages) in their district.

An extensive list of information which would be useful for planning purposes was then prepared by the project regional planner, circulated for comments, modified and then agreed by the district planners. Detailed Guidelines and Table-formats were then drawn up to assist the planners in providing uniform village-level information for entry into a computer database by the project. A series of visits were made by the project regional planning counterpart to the district planning offices to review progress, discuss any difficulties, and encourage early completion of these tables.

A computer database was created from hand-written tables of information on 146 variables for 86 towns or villages for Kwabre District, the first district to complete this task.

Using KUMINFO, computer maps showing selected results were displayed at a Workshop in August 1999, and suggestions made on how these results could be used to identify priorities for action in the next Medium-Term District Development Plan for 2001-2005. The remaining three districts subsequently provided information to help fill the information gaps and provide information needed for planning.

Geographical Information Systems for the management of natural resources in a peri-urban environment – KUMINFO

Introduction

Geographical Information Systems (GIS) are increasingly being used as a tool to manage information by individual research projects and organisations. Environmental management and analysis often require the type of interface provided by GIS to enable integration of data drawn from different sources as well as allowing access to management and modelling tools.

Establishment of the system.

Maintenance of the information system

A GIS has been developed during the course of the project, based on a pre-project prototype developed by GDS (Geographic Data Support) Ltd. which was called the Peri-Urban Demonstrator for Spatial Data Integration (PUDSI) system. As the project matured and the requirements of the researchers were defined, PUDSI has been enhanced and developed to the present system, known as KUMINFO v2 – Kumasi Information system, version 2. The GIS is based on commercially available software (Arcview, Spatial Analyst and the Access database) and runs in either the Windows95 or NT4 operating systems and is run in Kumasi by a GIS co-ordinator and a data manager with parallel systems in the UK.

Datasets have been added to the system digitally, by digitising from hard copy, scanning and as databases of attribute data. Throughout the project there has been liaison with the developers of novel GIS methods (Project R6880) to ensure that data collected by their team could also be accessed from within the system.

Base maps are provided in KUMINFO at a variety of scales and are a mixture of propriety datasets acquired specifically for project, freely available datasets, and data donated by Ghanaian institutions. Spatial data has been converted to either a latitude/longitude representation (geographic) or to the Ghana National Grid which is based on a Universal Transverse Mercator (UTM) projection with a local datum.

Topographic data has been acquired as indicated in Table 8. As well as topographic data, general thematic data has been added for the whole of Ghana and for the Kumasi area

(Table 9). Finally data being acquired for the project and generated by the component studies are being continually added (future use of the system will be made by project R7330, Peri-urban natural resources management at the watershed level, Kumasi Ghana). Available analyses and coverages in this category are shown in Table 10.

Table 8. Topographic data available in KUMINFO

Coverage	Origin	Scale
Ghana boundary	Arcview	1:3 million
Rivers and lakes	Africa Data Sampler	1:1million
Transport infrastructure	Africa Data Sampler	1:1million
Contours (ft)	Africa Data Sampler	1:1million
Built up areas	Africa Data Sampler	1:1million
Settlements	Africa Data Sampler	1:1million
Districts (Old)	Statistics Department, Accra	1:1million
Contours (m)	NRI	1:3million
Ashanti region districts - new boundaries	Ministry of Finance and Economic Planning, Kumasi	1:250,000
Transportation (Kumasi)	Surveys Department, Accra	1:50,000
Rivers (Kumasi)	Surveys Department, Accra	1:50,000
Settlement polygons Kumasi)	Surveys Department, Accra	1:50,000
Text (Kumasi)	Surveys Department, Accra	1:50,000
Contours (Kumasi)	Surveys Department, Accra	1:50,000
Roads	Water & sewerage, Kumasi	1:5000
Contours	Water & sewerage, Kumasi	1:5000
Rivers	Water & sewerage, Kumasi	1:5000
Property boundaries	Water & sewerage, Kumasi	1:5000

Table 9: Thematic data available in KUMINFO

Coverage	Origin	Scale
Whites vegetation map of Africa	Digitised at NRI	1:3 million
Soils, geology	FAO soil map of Africa	1:3million
Soils, geology	Soil Research Institute, Kumasi, (NRI/IRNR)	1:250,000
Protected areas	World Conservation Monitoring Centre	1:3million
50 km radius of Kumasi	NRI	1:1million
Labour patterns	ESRI Arcview dataset	1:3million
Forest boundaries	Forest Research Institute, Kumasi	1:1million
Forest buffer zone	NRI	1:1million
Forest Types	Forest Research Institute, Kumasi	1:1million
Meteorological Stations	NRI	1:3million
Monthly Potential Evapotranspiration	FAO CLIMWAT for CROPWAT,	1:3million
Mean monthly rainfall	Meteorological Department, Accra	1:3million
Mean monthly temperature	Meteorological Department, Accra	1:3million
Mean monthly maximum & minimum temperatures	Meteorological Department, Accra	Spreadsheet
1984 population statistics	Statistics Department, Accra	
Cattle Distribution	IRNR – by region	

Table 10. Data acquired for and generated by the project (and R7330)

Coverage	Origin	Scale
ADP index	Index of Aerial Digital Imagery (NRI)	1:50,000
Digital elevation model	Derived from 1:50,000 contours by NRI	
Kumasi City Region	ILMAD Urban Footprint study	1:250,000
Kumasi Commuting Zone	ILMAD, Urban Footprint study	1:250,000
Kumasi Waste dumps	Kumasi Metropolitan Assembly (KMA)	1:50,000
Bath imagery	Original PUDSI demonstration data	
Planning survey	Results of extensive village questionnaire (BIRD, Nottingham, NRI)	1:50,000
PRA Settlements	Institute of Land Management and Development (ILMAD/BIRD) linked to PRA reports	1:100,000
Rivers	Identification of river basins with stream orders (NRI for R7330)	1:50,000
Sand winning sites	Derived from Spot image	10m
Spot image 1994	Spot Image	10m
Trotro routes	Trotro survey	1:50,000
Urban gap land use	Analysis of Aerial digital imagery, IRNR, NRI	25cm
Village growth	SPOT Image/1:50,000 maps, analysis by GDS	10m
Village level participatory land use planning sites	Analysis of Aerial digital imagery – IRNR, ILMAD, BIRD, NRI	25cm
Water sampling sites	R7330	1:50,000

Data managers

Data managers were nominated in both the UK (at NRI) – Mrs. Judith Pender - and in Kumasi – Mr. Kingsley Boateng. These persons are the first contact for researchers needing access to KUMINFO. In addition a GIS co-ordinator – Dr. James Quashie-Sam - was identified in Kumasi to have overall responsibility for the GIS.

Data compatibility

Throughout the project the information managers have liased closely with the researchers to ensure that data is accessible on a variety of software packages. For example,

the large questionnaire surveys of the project have been compiled in the Access database while some of the smaller datasets have been compiled in Excel. Both of these data types are compatible with KUMINFO.

Identification of sites in Kumasi for siting of two KUMINFO systems and their installation

The primary site for KUMINFO in Kumasi was identified as the new building belonging to the Institute of Renewable Natural Resources (IRNR), UST. The director provided a dedicated air-conditioned room to house the system.

Two KUMINFO systems have are running in parallel at IRNR for several reasons:

1. KUMINFO is designed primarily to support the researchers involved in the Kumasi peri-urban research projects. To enable it to become operational in either regional or district offices in Kumasi would demand a systems analysis of the operational demands of such offices.
2. The data manager would not find it possible to support systems in outlying areas in an efficient manner under the present project.
3. Two machines were needed as the software required to handle full resolution Aerial Digital Photography conflicts with other peripheral software (notably the scanner software).
4. As it has turned out, one of the computers has remained unreliable despite frequent attention from project staff and IT engineers.

However, in order to demonstrate the system to district planners and to familiarise them with the potential of using GIS in the planning process, a CD-ROM has been prepared for each district containing relevant data and using free Arcexplorer software.

The system was installed in June 1997 and the Kumasi data manager given an intensive three week training in its use.

Data policy co-ordinating group

A data policy co-ordinating group consisting of Dr Quashie-Sam, Prof. Kasim Kasanga and Judith Pender was formed. This group has considered issues relating to both digital and hard copy dissemination of outputs from the GIS.

Recommendations on sustainability

Since the commissioning of R7330, Peri-urban Natural Resources Management at the Watershed level, Kumasi Ghana, the issue of sustaining the GIS in Kumasi has been addressed as part of that project. This has resulted in upgrading the system in Kumasi and the continuation of the data manager in Kumasi.

Outline recommendations on the use of GIS in District Planning Offices have been made to the PSL at an earlier date and will be refined in future proposals.

Advisory support, assistance and training in the use of KUMINFO

User manuals

A user manual has been prepared that helps the users access, query and output data from all parts of KUMINFO.

Briefing UK researchers on use and limitations of KUMINFO as a research tool

KUMINFO is available on two machines in the Environmental Sciences Department of the NRI in Chatham. All Chatham based researchers have free access to these machines.

KUMINFO has been demonstrated as a research tool at several meetings in the UK and Africa. The limitation of the system, especially in analysis of socio – economic and perceptual data has been focused on as part of DFID SEM project R7055 "Issues and methods in the joint application of GIS and participatory enquiry in natural resources research".

Training in Kumasi

Training in Kumasi has continued throughout the project with the data manager holding many demonstration and familiarisation sessions. In addition, extra training during visits to Kumasi by the UK data manager has enhanced the capabilities of the Ghanaian data manager and the project researchers. Topics covered include database construction including

designing input forms, the acquisition and user of aerial digital imagery, projection conversion, basic Avenue programming and on screen digitising.

Installation of the system and training in its use on sites as directed by the NRSP PSL

KUMINFO has been installed in Royal Holloway and Bedford New College and researchers trained in its use. The CD-ROM of planning data of Kwabre district has been supplied to Bangor University.

Peri-urban interface research meta-database

KUMINFO is designed so that data is accessed through a central meta-database. The integration and management of data into one database system removes inconsistencies arising from different sources of material at different scales and detail. Problems of data-exchange and access do not plague the user in such a system and they are not deterred by the prospect of devoting time to preparing and searching for data sets. Other key information such as the source, scale and copyright of the data is also held in the meta-database.

A system of protocols has been developed for exchanging data between systems in different locations. This is a simple list of unique numbers held at the different sites. Access macros have been written to enable seamless importing and exporting of data between sites.

Soil fertility

Waste stream products consultancy

A checklist for analysing the potential use of waste stream products for soil amelioration in peri-urban interface agricultural production systems was set up (figure 27, next page) and applied to a general review of their use.

The consultancy recommended that an audit of every processing operation in an area should be carried out to assess whether under-utilised by-products exist and whether soil amelioration is an option for use. The often uneconomic operation of small compost plants was pointed out and the many reports of the cost of a product having use in agriculture exceeding its value. Reference was made to the use of waste products in many countries including as Nigeria, Egypt, Indonesia and Ghana itself.

The additional benefits of organic matter apart from nutrients were listed and experiments in support of the assertions quoted, although it was noted that much more research needed to be done. Other uses of organic wastes were reviewed but there was little reference to economic studies on these alternative uses. The fact that organic wastes are probably undervalued for soil amelioration because of the range and long-term nature of their effects are not appreciated was highlighted. On the other hand, the dangers of their inappropriate use were also highlighted.

Despite the often unfavourable economics, it was pointed out that the fact that as peri-urban farming is often a survival strategy, few farmers could afford to purchase fertiliser of any sort and this argues for the use of waste materials as the only fertiliser option. However, the fact that many peri-urban farmers may be discouraged from using organic manures due to the insecurity of land tenure was cited as an important consideration.

For Kumasi, a number of products were suggested as worthy of further investigation, but animal manures, particularly poultry manure, were cited as having high potential, though there are problems of transport of the material. Options for the KNRMP suggested were to either work with the municipal compost plant, if and when set up, or with an NGO concentrating on higher income areas (it being easier to set up waste separation and collection services in such areas) or with NGO's in peri-urban communities. The most appropriate farming system for the application of the organic waste products were reckoned to be intensive and semi-intensive vegetable production.

A final section provided guidelines for the agronomic evaluation of waste products.

Figure 27 : Check list for analysing the potential use of waste stream products in the peri-urban situation.

Supply and demand for soil ameliorants

The results of the investigations into the types, quantities available and sources of soil ameliorants in the Kumasi peri-urban area are given in tables 40 and 41.

Table 40: Nutrients available from the chemical fertilisers distributed from Kumasi and the chemical fertilisers used in the peri-urban area

	Quantity of fertiliser distributed from Kumasi (tons)						**Quantity of nutrients available (tons)**		
	NPK 15 15 15	**NP 20 20 0**	**NPK 23 15 5**	**AS #**	**Urea #**	**Total**	**N**	**P_2O_5**	**K_2O**
1998 *	1550	1050	500	1150	550	4800	1052	518	258
1997	1400	1050	475	1150	390	4465	950	491	234
1996	1925	1100	600	1225	390	5240	1083	599	319
1995	175	115	125	300	150	865	210	68	33
1990~						2383			
1989~						3436			
	Quantity of fertiliser used in the peri-urban area (tons)						Quantity of nutrients available (tons)		
	NPK 15 15 15	NP 20 20 0	NPK 23 15 5	AS #	Urea #	Total	N	P_2O_5	K_2O
1998 *	155	105	50	115	55	480	105	52	26
1997	140	105	48	115	39	447	95	49	23
1996	193	110	60	123	39	524	108	60	32
1995	18	12	13	30	15	87	21	7	3

The flowchart (figure 28) summarises the present use of the various soil ameliorants.

It was concluded that, in peri-urban Kumasi, in terms of available principal plant nutrients, far more organic material which could be potentially used as fertiliser is wasted than the total quantity of inorganic fertiliser applied. Other beneficial effects of the organic materials, such as moisture retention, soil structure maintenance and soil pathogen control add to the arguments for fuller use of the organic materials available.

It was also recommended that the resources which appear to offer most potential are nightsoil and sewage sludge, municipal waste, sawdust and livestock manures. The majority of the agroindustrial wastes are either already used for other purposes (i.e. livestock feed and fuel) or there is little waste available. There is little available information on the economic values of these resources as soil ameliorants so it is not possible to make any comparison with the economic values of their current uses. However, it is generally the case that soil amelioration is perceived to be the least economic option.

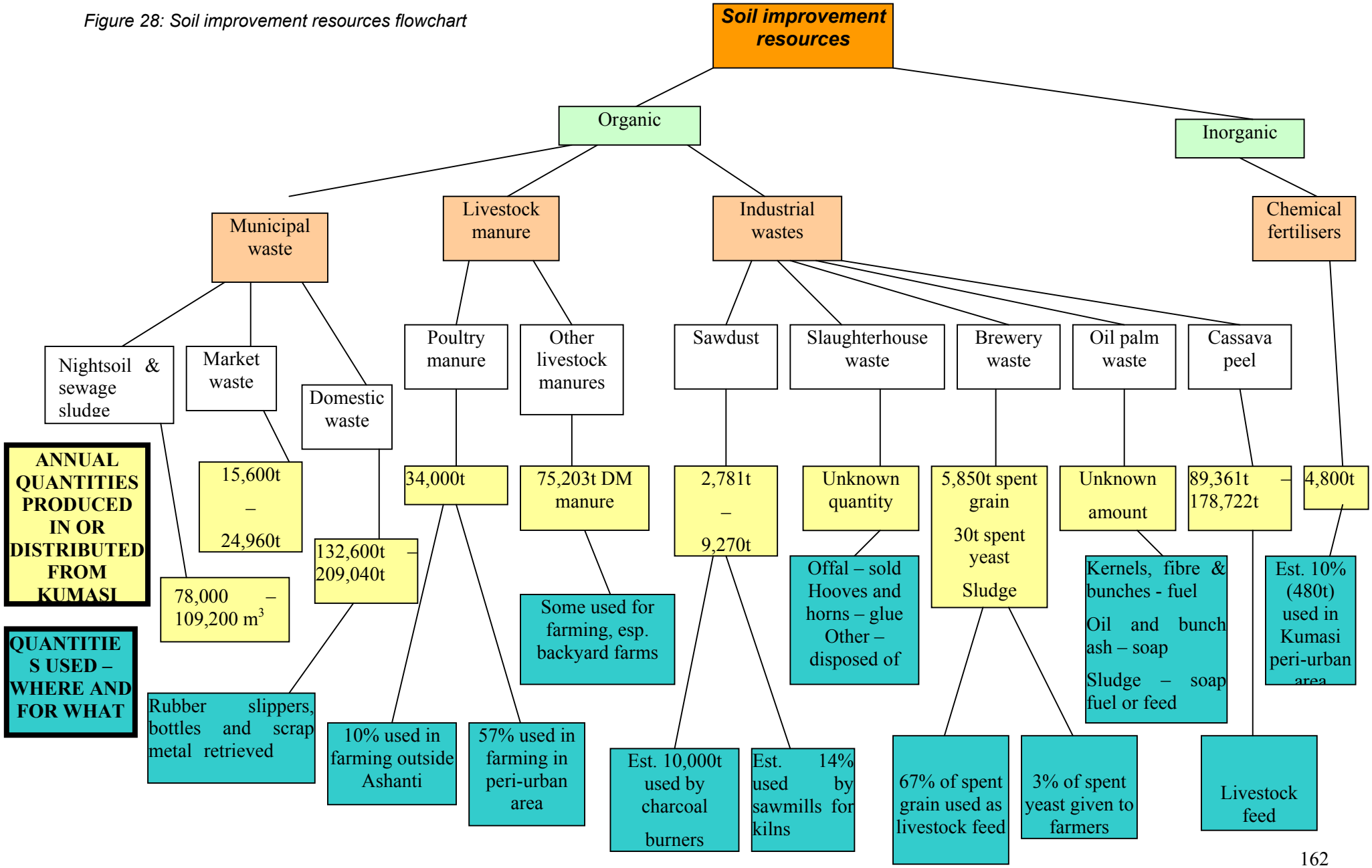
The component report has been published as Kindness (1999), "Supply and Demand for Soil Ameliorants in peri-urban Kumasi".

Table 41: Total nutrient content of the potential organic soil ameliorants in Kumasi

Soil improvement resources	Quantities available in the Kumasi peri-urban area	Nutrient content (% fresh weight)			Total nutrient content of soil improvement resources								
	Annually*	N	P	K	N			P			K		
					Min	Max	Av	Min	Max	Av	Min	Max	Av
Municipal waste	124,800t – 209,040t	0.6–1.5	0.18–0.8	0.83–1.27	749	3136	1753	225	1672	818	1036	2655	1753
Domestic waste	132,600t – 184,080t	0.6	0.18	0.83	796	1104	950	239	331	285	1101	1528	1314
Market waste	15,600t – 24,960t	0.3	0.09	0.5	47	75	61	14	22	18	78	125	101
Nightsoil and sewage sludge	78,000 – 109,200 m^3	0.6	0.09	0.25	468	655	562	70	98	84	195	273	234
Livestock manure													
Poultry manure	34,114 tonnes	1.46–1.9	0.17–0.6	0.17-0.84	498	648	573	58	205	131	58	287	172
Other livestock manure (1996)	Cattle 31,477t Sheep 55,457t Goats 16,645t Pigs 12,839t	0.2–0.8 0.6 0.6 0.5	0.03–0.2 0.13 0.13 0.18	0.1-0.66 0.99 0.99 0.42	63	252	157 333 100 64	9	63	36 72 22 23	31	208	120 549 165 54
Sawdust (1997)	2,781t – 9,270t	0.1–0.25			3	23	11						
Agroindustrial wastes													
Brewery waste	5,850t spent grain 29.9t spent yeast	3.0–5.51	1.22	0.15	176	324	250			72			9
TOTAL (mt/year) #					2332	5562	4252	615	2391	1477	2499	5076	4237

Key: * Fresh weight of raw material # The totals exclude nightsoil and sewage sludge because only volume figures are available, not weights

Figure 28: Soil improvement resources flowchart



Horticulture trials – poultry manure

In the first season there was a severe disease attack, probably of tomato wilt, *Pseudomonas solanacearum*. This occurred both on-station and on-farm. It is strongly suspected that the variety selected was highly susceptible to the pathogen spectrum encountered. On hindsight, it would probably have been better to use the farmers' usual variety, the round red type "Power", from their own seed selection, if not available from a seed merchant. This was used in the second season. The third season, okra, crop, gave yields similar to those obtained with earlier trials at Kumasi for this variety (Norman, 1992). Results for the three seasons are presented in the tables below.

Table 42: Effect of soil ameliorants on seedling survival, yield parameters and shelf life of tomato, on-station rainy season trials 1998.

Treatments / parameters		CON-TROL	PM	NPK + S/A	PM / NPK + S/A
No. surviving plants / 189	Field	120.0a	124.7a	121.3a	112.3a
"	Transformed	10.97a	11.17a	11.03a	10.61a
% survival	Field	63.5a	66.0a	64.2a	59.5a
"	Transformed	52.9a	54.4a	53.3a	50.5a
Total fruits hvst'd /100m^2	Field	993b	1393a	1257ab	921b
"	Transformed	31.1b	37.2a	35.4ab	30.1b
No. marketable fruits / 100m^2	Field	674.0b	995.7a	842.3ab	566.0b
"	Transformed	25.6bc	31.4a	29.0ab	23.5c
No. diseased fruits / 100m^2	Field	150.0a	165.7a	197.3a	172.7a
"	Transformed	12.2a	12.8a	14.0a	13.0a
No. pest dam'd fruits / 100m^2	Field	161.0a	224.0a	203.0a	170.0a
"	Transformed	12.3a	15.0a	14.3a	12.9a
No. cracked fruits / 100m^2	Field	8.0a	8.0a	13.7a	16.0a
"	Transformed	2.7a	2.8a	3.6a	4.0a
No. of fruits / plant	Field	8.1b	11.1a	10.4ab	8.1b
"	Transformed	3.0b	3.5a	3.4ab	3.0b
Projected No. fruits/ ha.	Field	99300c	139333a	125667b	92100c
"	Transformed	311.4b	371.6a	354.3ab	301.0b
Total wt. fruits / 100m^2		38.4bc	50.6a	45.6ab	29.6c
Wt. marketable fruits/ 100m^2		28.5bc	41.3a	35.3ab	21.4c
Wt. diseased fruits/ 100m^2		6.7a	5.3a	6.5a	4.6a
Wt. pest dam'd fruits / 100m^2		2.9a	3.5a	3.1a	2.9a
Wt. cracked fruits / 100m^2		0.33a	0.47a	0.67a	0.73a
Fruit wt. /plant (kg)		0.32bc	0.40a	0.37ab	0.26c
Projected wt. (t/ha)		3.8bc	5.1a	4.6ab	3.0c
Mean fruit diameter (cm)		4.4ab	4.7a	4.3bc	4.2c
Shelf life (days)		8.3a	9.3a	8.7a	9.3a
% marketable by wt.	Field	72.4ab	81.5a	76.9ab	71.1b
"	Transformed	58.5b	64.6a	61.4ab	57.6b
% diseased by wt.	Field	19.8a	10.4a	14.6a	16.7a
"	Transformed	25.9a	18.8a	22.4a	23.8aa
% pest damaged by wt.	Field	7.1a	7.0a	6.9a	9.4a
"	Transformed	15.3a	15.3a	15.2a	17.8a
% cracked fruits by wt.	Field	0.8b	1.0b	1.5ab	2.7a
	Transformed	4.1b	5.5ab	6.8ab	9.3a

Table 43: Mean tomato yields, on-farm trials rainy season 1998

Treatments / parameter	Total weight (gms.)
Control	947b
PM	4164a
NPK+SA	3550a
PM + NPK+SA	4566a

Table 44: Second season on-station results : residual effect of organic and inorganic fertilisers on yield parameters of tomato cv. 'Power'

Treatments / parameters	CONTROL	PM	NPK + S/A	PM / NPK + S/A
No. of fruits / plot	264.3b	609.3a	232.7b	498.7ab
No. of fruits / plant	1.597bc	3.150a	1.310c	2.480ab
No. marketable fruits/plot	205.0b	507.0a	184.3b	410.0ab
No. of cracked fruits/plot	40.33b	58.00a	30.67b	41.67b
No. of diseased fruits/plot	17.67a	38.67a	11.67a	38.00a
No. of insect dam'd fruits/plot	1.333a	5.667a	6.000a	4.000a
Wt. marketable fr./plot (kg.)	5.58b	18.56a	5.26b	12.87ab
Wt. cracked fruit/plot (kg.)	1.17b	1.64ab	2.85a	2.23ab
Wt. diseased fruits/plot (kg.)	0.33a	0.25a	0.10a	0.85a
Wt. insect dam'd fr./plot (kg.)	0.070a	0.039a	0.117a	0.072a
No. surviving plants/plot*	165.3	191.0	179.3	175.7
Mean diameter of fruits (cm.)*	4.0	4.1	4.0	4.4
Shelf life (days after hvstg.)*	8.7	8.0	8.0	11.3

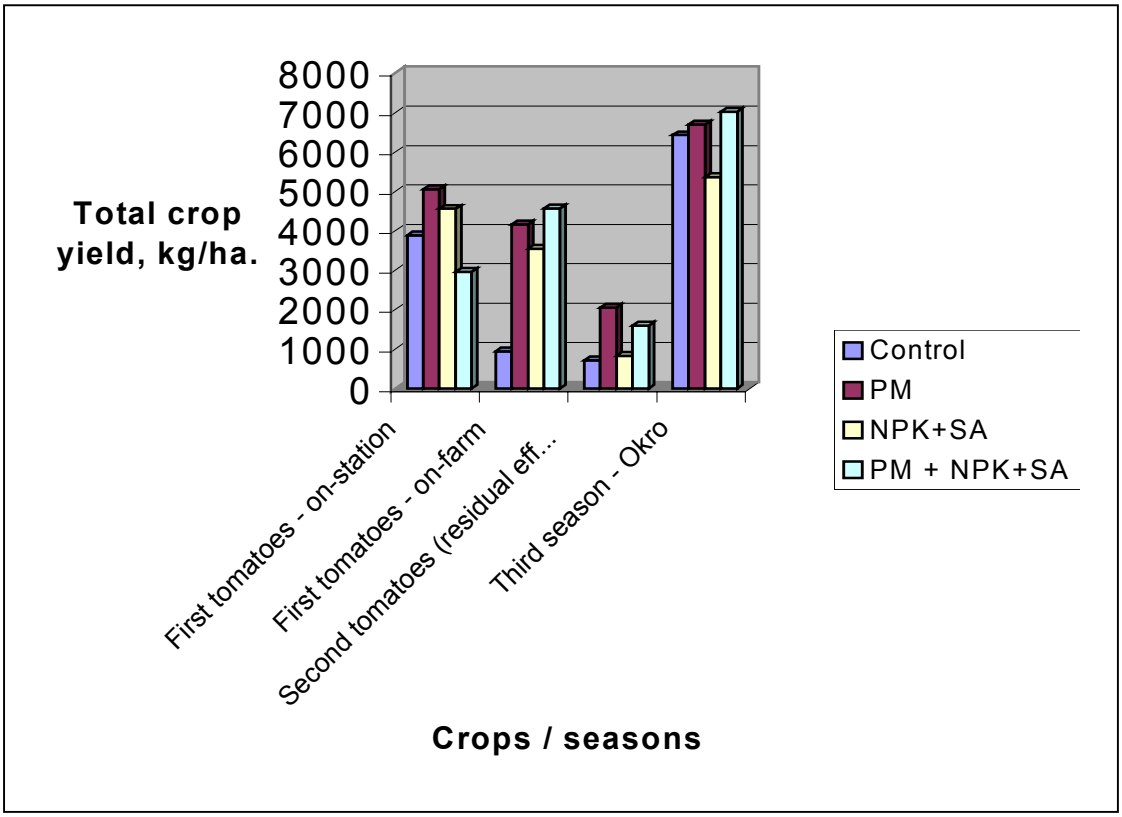
* Data not analysed statistically

Table 45: Field data results on the effect of poultry manure and inorganic fertilisers on vegetative and reproductive parameters of okra variety 'Asontem White'.

Treatments / parameters	CONTROL	PM	NPK + S/A	PM / NPK + S/A
Plant height (cm.)	143.4	138.8	145.0	152.0
Canopy spread (cm.)	58.7	60.5	61.1	63.9
No. of productive branches	3.9	3.3	3.6	3.7
Total no. of fruits harvested	3968	3893	3210	4179
Total no. of marketable fruits	3846	3893	3210	4179
Total no. unmarketable fruits	188	183	140	170
No. of fruits / plant	24.6	24.9	22.1	26.6
Total wt. of fruits hvst'd (kg.)	64.27	66.96	53.69	70.27
Total wt. of marketable fruits	58.93	61.82	49.50	65.09
Wt. unmarketable fruits (kg.)	5.33	5.14	4.29	5.18
Wt. fruits / plant (kg.)	3.9	4.1	3.5	4.3

The results of the 2 - year on-station and on-farm trials have shown that treatments that contained PM (that is, PM alone and the mixture of PM + NPK + S/A) proved superior in terms of crop yield to the application of inorganic fertilisers alone and the control in most trials. Figure 29 below illustrates this.

Figure 29: Summary of agronomic results of trials.



Economic analysis was only possible for the first season. Results indicate that poultry manure (at zero cost apart from transport and labour) gave positive returns to application at both the lowest and highest tomato prices encountered during the selling period whereas inorganic fertiliser gave a negative return at low tomato prices.

Table 46: On-station trial results and cost calculations

Treatment	Total wt. of fruits, KG.	Wt. of marketable fruits, kg.	Increment of marketable fruits over control, kg.	Additional labour costs for all treatments plus inorganic fertiliser costs	Value (€) of increment at €288/kg	Margin at €288/kg over additional costs with treatment, €	Value (€) of increment at C962/kg	Margin at €962/kg over additional costs with treatment, €
NPK	45.6	35.3	6.8	3563	1958	-1605	6542	2979
PM	50.6	41.3	12.8	1633	3686	2053	12314	10681
NPK+PM	29.6	21.4	-7.1	2780	neg.	neg.	neg.	neg.
Control	38.4	28.5	0	0	0	0	0	0

N.B. At time of the trial, £1 = c. C3750.

A marginal return to the cost of an input of twice that of its marginal cost is generally accepted as being the minimum as a basis for acceptance of an input by smallholder farmers. At the level of yields achieved, which as have been noted are very low, this would only be achieved with the values in the above table if the price received for the tomatoes was C962/kg (C50,000 per box, a price only reached in one week of the selling period). The maximum

permissible cost of the poultry manure would in this case be C(10681/2)-1687 = C3654 per 80kg or C45,669 per tonne. The cost of plastic bags for the transport of poultry manure is presently C18,750 and is used in the on-farm trial calculations below as its only material cost. An additional cost of C26,919 per tonne could thus be borne whilst still retaining the criterion of adequate return to convince farmers as outlined above, even with the poor yields incurred.

It is possible to calculate the increase in yield which would be required to pay back the costs of the extra inputs with the treatments. Table 47 refers.

Table 47: Yield increases required to cover additional costs of treatments, kg.

	NPK plot	PM plot	NPK + PM plot	Control plot
Tomatoes €15,000/box	12.35	10.86	12.24	0.00
Tomatoes €30,000/box	6.18	5.43	6.12	0.00
Tomatoes €50,000/box	3.71	3.26	3.67	0.00

The on-station mean increases in yield per plot were 12.8 kg for the poultry manure and 6.8 kg for the NPK. At those yield levels the input of NPK would have covered additional costs with tomato prices at the two higher levels, and the input of poultry manure at all price levels.

Partial budget calculations for PM, NPK and NPK+PM with the mean treatment yields for the on-farm trials and using the relatively high market price of C840/kg tomatoes show that break-even yields for the additional costs and return of the three treatments are

PM 480kg

NPK+PM 529kg

NPK 528kg

That is to say, poultry manure requires a lower yield increment to cover its use, given the costs applied above.

Nutrient balance study

A full report of the study, with results and conclusions on all aspects of the findings, is being separately published. The actual nutrient balances are mainly here discussed.

The first season's results are presented in Tables 48 and 49. Due to the low level of yields recorded (as noted in the section on horticulture trials - poultry manure), all nutrient

balances for the applied nutrients were positive for both the on-station and on-farm trials. However, even at the low yield levels, nutrient balances of NPK for the control treatment where no external inputs were added were negative, especially for nitrogen: the inherent nutrient reserves served as the main source of plant nutrients on the control plots. With an average total nitrogen uptake of 13.6 kg ha-1 on-station (Table) the estimated available nitrogen of 15.8 kg ha-1 (presented elsewhere) is almost completely (86%) depleted within one season of cropping. The depletion in the case of phosphorus and potassium was, however, not so dramatic. In the case of the on-farm trials, the depletion of the estimated available nitrogen (presented elsewhere), assuming an average total uptake of 8 kg ha-1 (presented elsewhere) ranged from 30 – 39% at Darko to 73 – 85% at Apatrapa and 85% at Duase.

Table 48: Nutrient balance, on-station, first season

	N	**P**	**K**
Control	-13.635	-1.516	-4.715
NPK	94.770	58.513	54.706
PM	160.200	46.348	60.248
PM+NPK	133.932	53.028	60.135

Table 49: Nutrient balance, average of on-farm results, first season

	N	**P**	**K**
Control	-7.968	-0.206	-2.324
NPK	100.294	59.751	57.303
PM	167.123	47.634	63.366
PM+NPK	133.318	53.693	60.206

The depletion in the case of phosphorus and potassium was, however, not so significant. The results indicate an urgent need for external nutrient inputs, especially nitrogen, to sustain high seasonal tomato yields in peri-urban Kumasi.

For the second season, without further application of any fertilisers whatsoever, a negative nutrient balance was again recorded under the control treatment (Table 50). The negative balance implies continued mining of soil nutrients. Examination of the estimated nutrient reserves in the soil (presented elsewhere) again indicates such nutrient mining to be more critical for nitrogen. Apart from the control, all other treatments recorded a positive nutrient balance. (Due to lost field data, as mentioned under horticulture trials - poultry manure, the analysis was not continued on-farm).

Table 50: Nutrient balance, on-station, second season

Treatment	Residual Nutrient in Soil (INPUT)-kg/ha			Total Uptake (kg/ha)			Nutrient Balance (kg/ha)		
	N	P	K	N	P	K	N	P	K
Control	-13.635	-1.516	-4.715	2.366	0.720	1.568	-16.001	-2.236	-6.283
NPK	94.770	58.513	54.706	3.749	0.498	2.142	91.021	58.015	52.564
PM	160.200	46.348	60.248	4.214	0.743	2.951	155.986	45.605	57.297
PM+NPK	133.932	53.028	60.135	2.845	0.936	1.481	131.087	52.092	58.654

Other important results from the tomato trials (two seasons) indicate that:

- Uptake of N by tomato is higher when N is supplied in the form of mineral fertiliser than poultry manure. The converse is true for phosphorus.
- Most of the phosphorus taken up by tomato (>90%) in all the trials is consistently stored in the shoot.
- The relative distribution of N and K in tomato shoot and fruits did not follow any consistent trend. At low crop yields, N, P and K are mostly stored (> 90%) in the shoot.
- Recycling by composting the tomato plant residue would therefore be beneficial (provided the plants are not diseased).
- The application of mineral fertiliser (15-15-15 NPK + sulphate of ammonia) significantly decreased soil pH of the topsoil from 6.30 to 5.73 and organic matter from 3.0 – 2.16%.
- The initial ECEC of the soil was significantly increased by all treatments.
- Poultry manure significantly increased initial soil P from 7.4 to 21.4 mg/kg (189%) and K from 0.35 to 0.55 cmol /kg (57%).

In the third season, okra, trial, the input nutrients consisted of the applied nutrients and the balance of nutrients at the end of the second tomato trial (Table 51).

The results show a negative balance for the control treatment. This was more so for nitrogen, followed by potassium. Apart from the control, all other treatments recorded a positive nutrient balance.

Table 51: Nutrient Balance for the third season (okra) trial.

Treatment	Total Input (kg/ha)			Total uptake (kg/ha)			Balance		
	N	P	K	N	P	K	N	P	K
Control	-16.001	-2.236	-6.283	15.145	0.337	10.073	-31.146	-2.573	-16.355
NPK	334.986	93.605	124.297	18.993	0.403	11.637	315.992	93.203	112.660
PM	201.021	118.015	112.564	15.033	0.329	8.834	185.989	117.686	103.729
PM + NPK	276.087	106.092	122.654	21.408	0.381	12.023	254.679	105.711	110.632

Other findings from the third season's results indicate that:

- The uptake of N was enhanced under PM+NPK followed by PM. K uptake was better under PM+NPK and NPK. P uptake was however better under NPK. These findings do not mirror those of the results for the tomato seasons.
- In general a greater percentage of N, P and K taken up by okro is stored in the fruits. In spite of this significant amounts of nutrients are stored in the shoot. Returning the okro residue to the soil through composting can contribute to soil fertility replenishment.

Horticulture trials – Mucuna

In the first year Mucuna completely overgrew and smothered the maize where the two crops were intercropped simultaneously, but it had no effect on the cereal at the other farm where it was planted.

At the end of the first year fallow period Mucuna had accumulated between 1.5 and 5.6 t/ha of dry matter and the weight of residue on the natural fallow field ranged between 2.6 and 7.6 t/ha. This is considerably higher than the Mucuna biomasses accumulated in the IFCSP trials in Brong-Ahafo which (assuming a moisture content of 90%) were about 2t/ha (Kiff et al. 1999).

The mean soil temperatures and moisture content values across the farms are presented in table 52. There were no significant difference in morning temperatures (MTO) and moisture content immediately after rainfall (SM1). However, afternoon temperature was lower and moisture content (after no rainfall) was higher on the mulched plots than the slash and burn plots. Zero tillage had soils with the highest moisture content (13.5%) and lowest temperature.

Table 52: Soil temperature and moisture content as affected by fallow and mulch management system

Treatment	MTO	ATO	SMO 1	SMO 2	
Zero till Mucuna	21.5	25.5	15.9	13.5	
Mucuna ridged & mulched	20.8	27.0	14.4	11.2	
Mucuna burnt & ridged	19.8	31.0	14.5	10.7	
Grass ridged &mulched	21.8	26.5	16.5	11.3	
Grass burnt & ridged	20.0	35.0	14.3	8.4	(farmer practice)
CV%	2.5	5.5	9.2	8.2	
LSD (0.05)	ns	4.5	ns	2.4	

MTO- Temperature measured at 8:00 GMT; ATO- Temperature measured at 1:00 GMT; SMO 1 and SMO2 Soil moisture assessed soon and 2 weeks after rainfall respectively.

The content of potassium, organic carbon and organic matter on the plots with burned plant residues was higher than on the other plots. However these values were not significantly different from the rest of the treatments except for the zero tillage. Table 53 refers.

Table 53: Test of significance of the nutrient status of the soil among treatments and farms

	pH	OC	OM	N	P	Ca	Mg	K	Na	Al	CEC
----------Ridges----------											
Treatment	ns	**	**	ns	ns	ns	ns	*	ns	ns	ns
Farm	**	**	**	**	**	**	**	**	ns	ns	**
----------Furrows----------											
Treatment	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Farms	**	**	**	ns	ns	**	**	ns	ns	ns	**

ns – Not significant, *- Significant (P= 5%) ; ** Highly significant (P<1%)

The higher content of nutrients on the other options compared to zero tillage may be attributed to nutrient concentration as a result of ridging. It may be noted that, for the ridged-mulched options, the content of potassium, organic matter, organic carbon and nitrogen were consistently higher for Mucuna compared to natural fallow. No significant differences existed in soil nutrient content under the two fallow systems probably because the significant part of the residue accumulated was not decomposed at the time of soil sampling. Decomposition could not take place because of the dry conditions that prevailed throughout the experimental period.

Weed pressure was highest (833 kg/ha) on the plots that were mulched with grass and lowest on the no till Mucuna plots. High incidence of weeds in the grass mulch may partly be attributed to infestation of seed from the grass. On the other hand, Mucuna effectively controlled weeds during the fallow period and the mulch it left suppressed weeds in tomato.

The major problem that was associated with Mucuna mulch was poor tomato establishment due to insect pests. As a result, about 40 % of the seedlings on the mulched plots were destroyed . The pests, mainly grasshoppers and crickets, hid in the mulch and destroyed the seedlings. However, pest damage was much lower on the other plots including those mulched with grass. Reasons for the difference in pest incidence between the Mucuna and grass mulch may be associated with differences in the micro climatic conditions that existed during the fallow periods. Mucuna, which is creeping, formed a compact and dense canopy while the grass (erect) formed a relatively open canopy.

Useful data on tomato yield was obtained from three farms only, for various reasons. Fruit yields were very low at all the farms and this may be attributed to inadequate watering of the crops during the fruiting stage. During this period the wells that served as water supply for the crops dried up. Amongst the fertilised plots, in the farm with the highest fruit yield the farmer practice (grass burned) gave the lowest yield while the zero till Mucuna gave the highest yield. On the other farms, the ridged-mulched Mucuna plots gave the highest yields and the lowest yields were again obtained from the burned plots. Comparing the fertilised and unfertilised plots, it was noted that the difference in yields due to chemical fertiliser was not consistent. For example at Darko, the zero till Mucuna with fertiliser yielded almost twice as was obtained from the same plot without fertiliser (1900 kg/ha compared with1037 kg/ha). On the same field chemical fertiliser had no effect on yield on the ridged mulched Mucuna plots. This suggests that soil nutrients were not the major factor-determining yield of tomato grown in the dry season but possibly moisture, temperature and weeds.

The farmers' assessment was that they have known Mucuna as a minor and traditional food crop from childhood but none of them ever knew that it can be used for any other purpose e.g. for weed control or soil fertility improvement. None of the farmers knew anything about cover crops prior to the trials. As a result of the trials, the farmers rated the weed control ability of Mucuna as excellent. All appreciated the benefits of mulching on soil moisture conservation. Despite the high incidence of pests and the extra work involved in mulching they were of the view that the technology has a high potential to improve yields of dry season vegetables since it is able to preserve moisture, which they regard as having been demonstrated as the most important factor determining yield.

For the second year the results have not been fully analysed as yet but there appear to be inconsistencies in the differences in yields between treatments. On the new trial plots, at one site the assessment was that crop growth and fruiting was best on the zero till Mucuna plot, followed by the Mucuna green manure plot. However, at another site the zero till plot was rated poorest because of low plant stand caused by insect pests. Here tomato on the grass-mulched plot was rated the best with no apparent difference between the farmer practice and

the Mucuna as green manure. The lack of benefit from the green manure would appear to be due to the slow rate of decomposition of the residue, which was incorporated a few days before planting out of tomato seedlings. Even at fruiting stage the residue ploughed under the soil had not fully decomposed; even leaf laminae were still intact and one would assume that nutrients remained unreleased from the manure. This contrasts with the results of the IFCSP trials, in which the lack of significant differences in dry season tomato production with green manuring was attributed partly to release of the green manure nutrients before the tomato could make use of them: transplanting of tomato seedlings in this case had been 81 days after green manure incorporation (Kiff et al. 1999).

The major findings can be summarised as follows:

- Mucuna as a cover crop reduced afternoon temperatures and maintained high moisture content compared with slash and burn.
- Yields were generally better on the mulched plots in the first year
- Insects, particularly crickets, tend to hide under the mulch and can cause significant plant losses
- Farmers appreciated the positive effect of mulching on crop growth during the dry season.

Poultry manure extension

Two approaches were used in evaluating the use of PM with farmers. These were

a. the assessment of changes in farmers' knowledge, attitudes, skills and aspirations (KASA); and

b. evaluation of field results.

Meetings to assess farmers' KASA with regard to PM were held by all AEA's. Some findings from these meetings follow.

The records of the assessment show that farmers are prepared to use PM both on staple food crops and vegetables and are aware of it having more than one positive effect. Table 54 shows that crop yield, disease status and effect on drought were the three positive effects most frequently recorded. The second and third responses might not have been expected and may indicate awareness by farmers of the linkage between plant vigour and disease susceptibility, also of the potential of PM to improve water-holding capacity of the

soil.

Table 54: Perceived positive effects of use of PM.

District	Most commonly cited positive effects of use		
	Increases crop yield	Positive effect on crop disease status	Positive effect in drought
BAK	85	49	23
Kwabre	Not fully recorded		
Atwima	53	53	61
KMA	98	41	26
ALL	236	143	110

A number of perceived negative effects of PM were also recorded, though fewer farmers mentioned these than the positive effects. The primary concern is that of scorching of crops under certain conditions. These negative effects were more frequently mentioned by farmers in KMA than elsewhere, possibly because of their generally greater familiarity with the substance than in other districts. As confirmed by the RCS on his monitoring visits, the method of application of PM favoured by farmers is broadcasting, and rather more would prefer to do this after planting. Presumably this is seen as the least labour-intensive and most convenient technique (but could also lead to scorching).

Both positive and negative attitudes to PM were recorded, with the offensive smell the most important single disadvantage; however, three times as many responses were recorded to the idea that PM could not damage health compared to the idea that it could make the user ill. Tables 55 and 56 refer.

Table 55: Positive attitudes of respondents to poultry manure.

District	Positive attitudes voiced		
	1. No health problem	2. Can use to check erosion	3. Can use in fish ponds
BAK	80	14	6
Kwabre	Not fully recorded		
Atwima	58	0	0
KMA	35	0	3
ALL	173	14	9

Table 56: Negative attitudes of respondents to poultry manure

District	Negative attitudes voiced		
	1. Bad smell	2. Not comfortable handling it	3. Can make you sick
BAK	101	37	9
Kwabre	Not fully recorded		
Atwima	68	34	0
KMA	112	0	58
ALL	281	71	67

The results from the self-assessment of farmers' skills suggest that application is found to be easier than storage and that about half of the respondents have been sufficiently interested to carry out their own comparisons of application methods.

As regards aspirations of farmers with regard to PM, clearly a large number of farmers is convinced of the value of using PM, most often citing better yields, income and living standards as a result of using it.

In the farmers' evaluation of field results the first five most commonly made observations were all positive comments, of which the improvement in crop vigour was most noticeable. Remarkably, drought resistance came in second, followed by size of harvestable crop parts. The increase in weed growth was the most important negative effect noted, and is probably partly due to the popular method of broadcasting the PM.

To round off the evaluation sessions, farmers were asked to list the principal constraints to use of PM and propose solutions. Under constraints, a large proportion agreed that the poor required some assistance with transport for the manure, a smaller number citing the high cost of transport as the principal constraint to use. For the most part, farmers proposed that they should find their own solutions to the problems identified. A large number, however, proposed more trials and demonstrations of PM.

The review of results from the field exercise gave rise to the follow-up proposal that a workshop should be organised to bring together poultry and crop farmers to discuss problems of utilisation of PM. Participants also included MoFA staff at front-line and district level, and project research collaborators. 34 farmers, 31 MoFA staff (including the Acting Regional Director), 3 researchers and a representative of the Ghana Organic Agriculture Association attended. The results of the discussion groups indicated that, whilst there was no solution seen to the labour costs involved in carting and transporting the PM, for transport participants suggested that:

a) farmers should form groups to cart the manure in large quantities

b) farmers should site their fields near poultry farms if possible

c) poultry farmers should consider subsidising transport of the material

The MoFA also carried out two demonstrations, near its head offices at Cadbury Hall, Kumasi, one in the major rainy season with poultry manure applied through broadcasting and one in the minor season one in which poultry manure was applied through ring-application. Results indicated that there was 50% increase in yield from the use of poultry manure over non-manured or fertilised plots in the major season and 30% increase in the minor season.

As at the end of 1999 farming season, it was reported that 320 out of the 800 farmers targeted in the four districts had adopted the technology. It is envisaged that the promotion of the use of poultry manure by peri-urban farmers will continue by MOFA staff so as to maintain the gains from the KNRMP.

Compost extension

Initially 42 farmers expressed interest in the project and they formed themselves into the Duase Organic Farmers' Association. The opening workshop was also attended by four collaborating scientists from UST. Topics presented were

- Introduction to KNRMP
- Decreasing soil fertility levels and sustainable food production in peri-urban areas
- Importance of compost in crop production
- Practical composting processes

During the following months, assisted by the facilitator (the summary of his diary was shown in the Research Activities chapter), both pit and heap compost-making methods were carried out on the communal site and initially farmers preferred the pit method because, once dug, the filling process is quick and easy. The heap was kept in place by banana stems around the sides. The farmers themselves then replicated the efforts on their own farms. Some samples have been taken for chemical analysis but the results are not available at time of writing.

The first materials to be used were poultry manure and sawdust, carried in by the project from a nearby poultry farm and Anloga sawmills in the municipality respectively. This was combined with ash, household wastes and fresh grasses. Later the farmers have concentrated on materials obtainable locally in the village, mainly household waste, dry and green vegetation and animal manures including poultry manure.

Farmers, of which a high proportion are women, have tried their matured compost on vegetables, appreciated the response of their crops, and invited others to witness. Other farmers from around Kumasi became interested and have purchased compost from Duase.

A second workshop was held in October 1999, attended by 35 farmers with resource persons from UST and MoFA, for the farmers to share their experiences and also address any problems they might have encountered. A final workshop is planned for the month of March 2000.

With the onset of the dry season, those without irrigation facilities (the great majority) reduced their farming activities and use of compost. The GOAN therefore took advantage of the dry season to train farmers on integrated pest management (IPM) practices through the farmer field school (FFS) approach. This project is funded by the DFID through the IPMForum and managed by NRI in collaboration with the HDRA and has dovetailed into the KNRMP work with the same group of farmers. During the final KNRMP workshop one group of participants visited Duase to observe and discuss the work being done by KNRMP and IPMForum projects. The IPMForum work has built upon the successful implementation of the KNRMP compost programme.

During the course of the year the pressures under which peri-urban farmers suffer were highlighted by the chairman losing his farm to building plots; and the communal composting plot is now also under threat.

One leaflet on "Small-scale Composting for Sustainable Agriculture" for use by farmers and extensionists, using the experiences of the KNRMP Duase work, has been produced and a second is about to be published. The KNRMP assisted the production of a series of eighteen radio programmes on the local FM station Garden City Radio featuring project scientists, collaborating farmers, and general GOAN extension messages. There has been a good response both by phone-ins during the programmes and correspondence afterwards, mainly through GOAN.

Figure 30: GOAN general secretary and Duase farmers with the communal heap compost

Urban natural resources

Individual resource studies

The samples as estimated percentages of the total participants in the production systems within the urban area vary from 0.3% in the case of the backyard crop production to 59% for aquaculture. In some cases the production systems are concentrated in certain areas of the city.

The studies show that the socio-economic characteristics of the urban natural resource managers (owners, farmers and gatherers) vary considerably with the type of natural resource. However, most forms of production have a strong gender bias (Table 57).

Table 57: Gender of respondents in the individual urban resource studies

Production system	% respondents males	% respondents females
Cattle	96	4
Sheep and goats	n.r.	n.r.
Pigs	92	8
Poultry	92.5	7.5
Small animals	100	0
Aquaculture	92	8
Backyard gardening	47.5	52.5
Fuelwood gatherers	8	92

The extremes can be seen in the poor fuelwood gatherers who have little or no capital to outlay and consequently low returns, yet are often entirely dependent on the activity for their livelihoods; and the rich large-scale poultry farmers and some of the cattle owners, who may invest millions of cedis and reap consequently high returns, but for whom the activity is secondary to an established non natural-resource-based business or occupation. For others, for example many of the backyard crop producers, the activity is at least partly a hobby.

A broad characterisation of the systems as described in these studies on the basis of capital requirements and returns can thus be suggested:

		Proportionate level of returns	
		High	Low
Capital requirements	High	Cattle, poultry	Aquaculture
	Low	Fuelwood gathering, small animals, pigs, sheep and goats	Backyard gardens

These studies provide a wide-frame focus on the range of opportunities exploited for natural resource production in the Kumasi urban area. They stand as individual commodity-

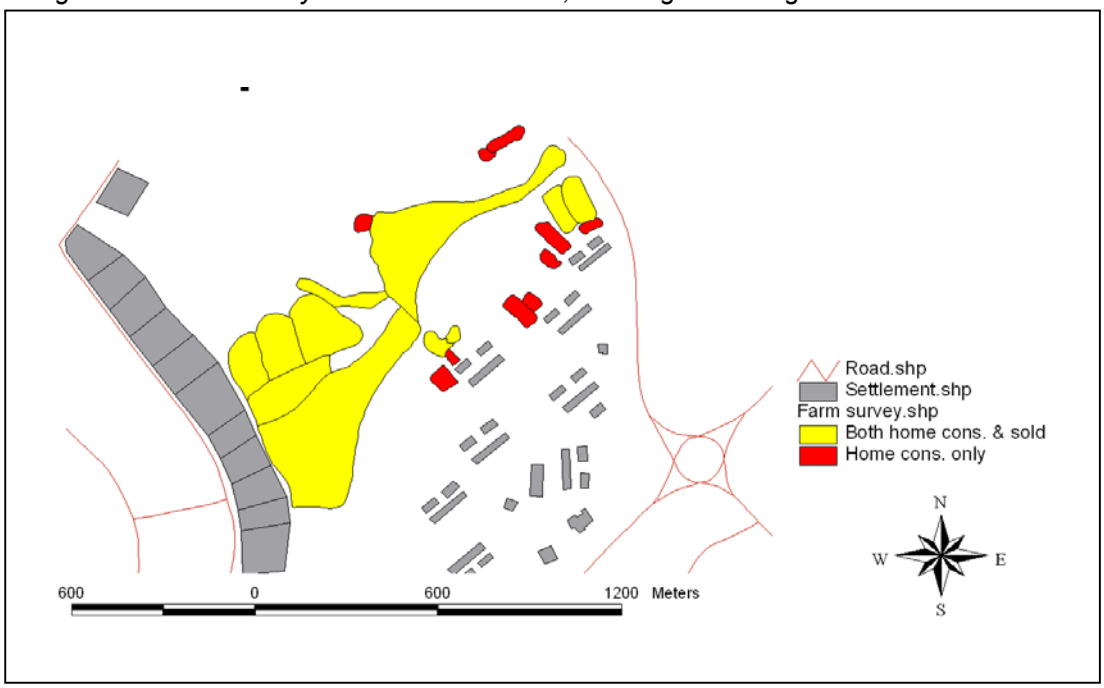
based, primarily descriptive, surveys of the various production systems and the report is not intended to provide a comprehensive analysis of natural resource production in the Kumasi urban area. However, the overview section which precedes the individual reports provides some reflections on and analysis of the common themes in the individual studies and suggests a number of possible fruitful areas for continuing research.

The reports will also be made available as text files through an interface on the project GIS at the Institute of Renewable Natural Resources in Kumasi and at NRI in UK.

Urban gaps study

The practice of agriculture in the gaps between urban development in the city of Kumasi may be characterised as based on food security as a prime motive, but with an increasing diversity of crops and some specialisation in vegetables for the market. From our limited survey we may suggest that the food security aspect predominates in the poorer areas (South & North Suntreso) whilst income is more of a motivation in the richer area (Subin /Asokwa). The plots and the primary purpose of cultivation for South Suntreso are shown below (figure 30) as an example of the information which can be derived from the use of aerial digital photography and GIS analysis of the survey results.

Figure 31 : Plots surveyed in South Suntreso, showing reasons given for cultivation.



Most of the cultivators are low-income men and most are not indigenous to the city and the region, although they may have lived there for several or many years. This latter finding may be due to either the lack of land for these people elsewhere in the region or also a

greater cultural tradition of relatively intensive small plot cultivation.

Whilst many of these findings typify the range of findings in other cities (Koc et al. 1999), the odd feature about these farmers is that they appear to feel quite secure on their land even though they have no title to it, either through a traditional or governmental authority. Many plant trees, partly as boundary markers. It may be that some of the urban farmers on government land feel more secure than those on stool or family lands because it seems unlikely that their (urban) land will ever be taken for development except in the very distant future, whilst those on family or stool land are only protected against immediate use.

The farmers believe that in future the land will lose its fertility because of the farming practices used. In general, with notable exceptions, the intensity of cropping on these urban gaps is not greater than can be found in peri-urban village valley bottoms around Kumasi. There is clearly scope for providing advice on improving the intensity of husbandry, but the issue of insecurity of official tenure may prejudice government employees offering services. Were the official generally permissive attitude towards urban agriculture in Kumasi to become a more enabling one much benefit for the nutrition and incomes of the poor could result. Times are changing, and there is a globally widespread and growing assertion that urban agriculture simply cannot be ignored any longer (Quon, 1999).

Planning

Peri-Urban Definitions

The Kumasi Urban Footprint Survey

The Kumasi City Region has been defined by the Kumasi Natural Resources Management Project (KNRMP) as the Kumasi Metropolitan Assembly (KMA) area plus the surrounding four district assembly areas contiguous to it: Kwabre District to the north of KMA, Ejisu-Juaben District to the east, Bosomtwe-Atwima-Kwanwoma District (B-A-K) in the south, and Atwima District west of KMA. Greater Kumasi covers a total area of about 2,176.sq.km., and had an estimated population of nearly 1.2 million in 1996. The 1984 Population Census of Ghana provides the latest reliable population figures, but as part of their 1996-2000 Medium-Term District Development Plans, each of the district assemblies produced simple population projections for their district, based on assumed rates of population growth. Table 58 shows the estimated distributions of population, by districts, for 1984, 1996 and 2000.

Table 58: Demographic Characteristics of the Districts in the Kumasi City Region.

	KMA	Atwima	B-A-K	Ejisu-Juaben	Kwabre	City Region Total
Area (sq.km)	254.15	2460. **	681.80	637.40	246.80	4,280.15
1984 Population	489,586	86,200	87,200	83,465	78,923	825,374
% Growth p.a. (Estim.)	3.1%	3.6%	2.5%	3.5%	3.0%	3.12%
1996 Population (Estim.)	710,213	132,900	117,872	122,606	109,780	1,193,371
2000 Population (Estim.)*	803,974	155,965	137,977	157,634	127,180	1,382,730

Sources: Various District Assembly District/Metropolitan Development Plans, 1996;
**Atwima District Area from Ministry of Local Government & Rural Development 1996, Ghana: The New Local Government System, Appendix 1, p.65.
* Uses High variant figures for 1996-2000 projections.

Although the creation of district assemblies in 1989 under Ghana's Decentralisation Policy had included a relatively small extension of Kumasi's city boundaries, Kumasi's peri-urban areas associated with the direct influence of the city, clearly extend beyond these boundaries into the four neighbouring districts, and perhaps beyond to a wider area. In order to avoid creating artificial or special purpose areas, an initial decision was taken to avoid splitting the basic administrative units, the district assemblies, so that the entire five districts were included. This ensured that villages likely to become peri-urban areas of Kumasi in the future would also be included.

In order to check the validity of this definition, however, an Urban Footprint study was conducted for KNRMP in 1997 by Tony Edmundson, a planner with the Land Administration Research Centre (since renamed Institute of Land Management and Development, ILMAD), UST, Kumasi. Details are provided in the Inception Report. Simple indicators of marketing and communications were used to define an outer boundary of Kumasi's daily influence, and a smaller inner journey-to-work or commuting zone. Ten market queens, the dominant wholesalers and market retailers for each commodity, were interviewed to determine the villages visited by Kumasi traders on a daily basis, or which supplied perishable foodstuffs to the city, or are dependent on Kumasi for their daily needs of local or imported produce. Trotro (minibus) operators were also interviewed to determine the number of vehicles per day travelling to outlying towns and villages on the 12 main routes into Kumasi. Trotro station overseers, drivers, and random samples of passengers were interviewed to determine the number of vehicles per day, the average number of trips per day for each vehicle, the type of foodstuffs conveyed, and the presence of daily commuters. The outer limit incorporated the marketing information, but was defined on the basis of 5 vehicles each making at least 5 trips per day, which would keep a trotro fully occupied for the working day with its journey times, plus loading, unloading, and waiting times. The commuter zone was defined on the basis of 10-12 trotros per day carrying commuters. Both zones were irregularly-shaped and elongated only along certain roads; the outer zone was about 60 km, but ranged between about 25 km. and 85 km., and the inner commuting zone varied between 25 - 45 km., averaging around 32 km from Kumasi's Kejetia Central Market.

When mapped and displayed in KUMINFO, however, all four districts were included in Kumasi's journey-to-work zone, but only the western half of Atwima District, the central part of eastern Ejisu-Juaben District, and the eastern end of Bosumtwe-Atwima-Kwanwoma District were found to be beyond the outer limit of Kumasi's daily influence. Although not part of the commuting zone, three more districts have at least half of their areas falling within the outer limit of Kumasi's urban footprint: this included all of Afigya Sekyere District, north of Kwabre District, the eastern two-thirds of Ahafo Ano South District, north-east of Atwima District, and the northern half of Amansie West District, south-west of Bosumtwe-Atwima-Kwanwoma District. At some future stage, consideration might need to be given towards their inclusion in an extended Kumasi City Region, together with three further districts in which about one-third of their areas fall within Kumasi's daily influence.

Commuting and Trotro Movement Patterns

Currently insufficient information exists on the spatial distribution and scale of urban developments within the city region. It is these development pressures which result in land

use conflicts and contributes to increased pressures on renewable natural resources in particular peri-urban villages. Adequate knowledge becomes a prerequisite for tackling environmental problems more effectively, and it is needed for setting priorities in the allocation of resources to respond to change and to improve or protect the human and natural environment. Only generalised impressions exist on the direction of Kumasi's growth and where development pressures are greatest in the peri-urban interface there. Although spatial variations in population changes should be revealed when the forthcoming April 2000 Population Census of Ghana is processed, until then there is a dearth of information about which villages have gained in-migrants, additional buildings or households. More direct information is needed for planning purposes on the geographical distributions and numbers of land sales taking place in each village, and on land prices being paid. Planning decisions would also be improved if more information is available on the numbers of plots actually being developed and completed for housing, and on the demographic, social and economic characteristics of the occupants of new houses. Substantial research resources will be required to obtain the necessary information on the actions of traditional chiefs and market forces, however. As a simple indicator of where these urban development pressures are currently taking place, KNRMP has undertaken brief pilot surveys of trotro[1] vehicle movements and passengers to identify the main areas where commuting (daily journeys-to-work) are currently found.

At 12 main trotro stations on routes beyond the KMA boundary, a census of trotro (minibus) movements to and from Kumasi was undertaken on different, representative days of the week. Two enumerators recorded each vehicle by its license number, its departure time, minutes spent waiting for passengers, and the numbers of passengers joining or leaving each trotro. In total. 1693 trotro vehicle-movements were enumerated, although difficulties were encountered through not reaching two trotro stations until about 8 a.m. instead of 6 a.m., and the trotro census had to be terminated early at 4 p.m. instead of 6 p.m. at another station; illness also meant that vehicles arriving from Kumasi at a fourth station were enumerated between 8.30 a.m. and 3.40 p.m.. A quota sample, with a target of 36 passengers at each trotro station in each direction, was also conducted at each of these 12 trotro stations. Simple questionnaires were designed for the interviewers to obtain information on the purpose of the journey, the respondent's occupation, age, sex, and home village, together with the frequency that the journey was undertaken. For passengers waiting to board vehicles towards Kumasi, the target quota was achieved at 10 trotro stations, although sample numbers were exceeded in 4 of them, but fell short in 2 stations. Passengers departing from vehicles arriving from Kumasi were more difficult to stop for interviews, so that the target was achieved in only 5 stations, although exceeded in 3 of them; between 23 and 29 interviews only were achieved

[1] Minibus

in 5 trotro stations, though, and in 2 more trotro stations less than half the target, only 11 or 17 interviews, were conducted.

Three trotro stations are on northern trotro routes, and three each on eastern, southern and western routes. A total of 817 vehicle movements to Kumasi were enumerated, involving 389 different trotros. Throughout the day, vehicle movements are greatest to Kumasi from the three northern trotro stations (297 or 36.4% of the total of 817 vehicle movements to the city), followed by the three trotro stations on the eastern routes into the city (207 or 25%). In contrast, vehicle flows into the city from the three southern trotro stations (173 or 22%) and particularly from the three western trotro stations (135 or 17%), are substantially less. Hourly flows between 6 a.m. and 6 p.m. have been tabulated, and trotro flows per hour and for 3 hour time periods during the day have been plotted from the database and displayed in KUMINFO. Between 6-9 a.m., when commuting into Kumasi would be expected, similar numbers of vehicles travelled towards the city from the east and the north, 63 and 62 respectively, substantially more than trotro movements from the south (30) or the west (18). For the eastern routes, this represents peak flows, with 31% of all its trotro movements to Kumasi, whereas numbers rise on the other three routes during the next two time-periods either side of midday. All except the northern stations (perhaps due to the undercount at its busiest trotro station) rise again after 3 p.m. when vehicles bringing passengers home from the city after work or other activities return again to Kumasi. Vehicle movements to Kumasi ranged from one or two only during 13 separate hourly periods, mainly in the west, up to the busiest time with 15 trotros per hour at one of the northern stations. The direction and timings of these vehicle movements into Kumasi have implications for traffic congestion in the city.

Where possible, the 18-seater minibuses wait until they are completely full, so that long waiting times at a trotro station is a further indication of insufficient passengers - except when more passengers elsewhere are known to be waiting, such as at the end of the working day in Kumasi. Waiting times longer than 15 minutes are experienced by 25 vehicles (12%) in the east, 13 vehicles (10%) in the west, 12 (7%) in the south, but only by 3 vehicles (1%) in the north. Average waiting times confirm this since they range between 8.16 minutes in the east down to 4.78 minutes in the north. In contrast, 156 vehicles (19%) set out completely full; although the number was highest in the north (59), this represented a lower proportion (20%) than the 53 vehicles (26%) in the east, due mainly to the influence of early morning vehicles to Kumasi.

7,706 passengers are carried towards Kumasi. The northern (2,580) and eastern (2,375) trotro stations dominate, contrasting with the smaller numbers from the south (1,494) or the west (1,257). 2,331 of these passengers joining trotros to Kumasi, however, are early in the morning between 6 - 9 a.m. when journeys for employment purposes might be

expected. In the east there are 1,058 early morning passengers, 45% of the total carried from these three eastern trotro stations. This contrasts with the north which has 656 passengers, 28% of all those travelling from the three northern stations. Numbers are lower in the south and west, with 359 and 258 respectively, but these represent 24% and 21% of the total passengers carried from these trotro stations.

In order to identify the numbers commuting to Kumasi, or undertaking a daily journey to work, 822 of these passengers were interviewed. 339 are males and 483 females. Nearly half (405 or 49%) are aged 30-39, 51% of the males and 48% of the females. Another 204 (25%) are aged between 20-29, including 25% of the males and 26% of the female passengers. Only 31 or 4% are aged 50 or more, and only 29 (3%) are less than 20 years old. Most undertake this journey on a daily basis, (382 or 46%), but a higher proportion of male passengers do so (216 or 64%) than female ones (166 or 34%). 32% of the female passengers in the sample travel twice a week, however, and a further 15% travel three times each week. Trading is the purpose of the journey for over three-quarters of those surveyed, either for selling (338 or 41%) or buying (287 or 35%). Nearly one-third, 267 or 32%, however, travel for work-purposes, either for employment (133 or 16%), self-employment (118 or 14%), or business (16 or 2%). The remaining 30% travel for social purposes (107), shopping (60), retailing (34), medical (13), or schooling or other purposes (29), together with 1 seeking work. Among the 822 passengers, 45 different occupations are represented, plus 30 students and 23 unemployed persons, but only 12 occupations have at least 10 represented. 367 (45%) are traders, 323 of whom are female, however, followed by masons (81), farmers (45), teachers (41 of which 26 are female), tailor/seamstresses (30, with 25 female) and hairdressers (22, all female). Other significant occupations are hawkers (19), drivers/drivers' mates (17), carpenters (14), civil servants (13), steel benders (12) and auto mechanics (10).

Indirect indications of the geographical origins of commuters to Kumasi from the analyses of trotro vehicle movements, waiting times, passengers carried, and the survey of a sample of trotro passengers, all suggest that more commuters travel daily from the north, followed by the east. A series of calculations have enabled the issue of the origins of daily journeys-to-work to be directly addressed. Table 59 provides estimates of the number of daily commuters for each of the 12 trotro stations. Also shown is information on the total numbers in the passenger sample, the number and proportion of daily journeys, the number and proportion of commuters, which are then applied to the total number of passengers carried to Kumasi.

Table 59: Estimated Numbers Travelling Daily to Work in Kumasi by Trotro, by Twelve Trotro Stations, 1999

Trotro Stations	Sample Total	No.of Daily Journeys	% Daily Journeys	No.of Commuters	% Commuting	No. of Passengers	Estimated Commuters
Abirem	92	39	42.39	15	16.30	535	87.23
Afrancho	76	41	53.95	31	40.79	647	263.91
Atimatim	59	32	54.24	27	45.76	1398	639.76
NORTH	227	112	49.34	73	32.16	2580	990.90
Ejisu Besease	47	22	46.81	11	23.40	734	171.79
Anwomaso	90	48	53.33	22	24.44	881	215.36
Deduako	69	34	49.28	20	28.99	760	220.29
EAST	206	104	50.49	53	25.73	2375	607.43
Atasonomanso	60	28	46.67	25	41.67	789	328.75
Daaban	59	40	67.80	20	33.90	434	147.12
Esereso	78	44	56.41	18	23.08	271	62.54
SOUTH	197	112	56.85	63	31.98	1494	538.41
Bokankye	60	17	28.33	12	20.00	210	42.00
Apatrapa	53	19	35.85	11	20.75	356	73.89
Kromoase	79	18	22.78	16	20.25	691	139.95
WEST	192	54	28.13	39	20.31	1257	255.84
TOTAL	822	382	46.47	228	27.74	7706	2392.57

Trotro stations with over half of the sampled passengers travelling daily are Dabaan (68%) and Esereso (56%) in the south, Atimatim (54%) and Afrancho (54%) in the north, and Anwomaso (53%) in the east. Only 28% make daily journeys from the three western trotro stations. The numbers of commuters, defined as those travelling for employment, self-employment and business on a daily basis, are also shown, together with the percentages of sampled passengers commuting. As interviews were conducted with passengers leaving trotros as well as waiting to join them, these figures are adjusted to remove those living in Kumasi but travelling out to the 12 trotro stations. Over one-third of the sample of passengers are commuters at four of the trotro stations - Atimatim (46%) and Afrancho (41%) in the north, Atasonomanso (42%) and Dabaan (34%) in the south. The trotro station with the lowest proportion of daily commuters is Abirem (16%) in the north, but all three stations in the west only have about 20% of the sampled passengers travelling to work on a daily basis. The percentages of commuters are then applied to the numbers of passengers joining vehicles to Kumasi enumerated in the trotro vehicle survey, to produce the estimated number of daily commuters, shown in the final column of the table. This shows that more travel for work on a daily basis from the north (991), largely due to the high levels from Atimatim (640). Although Atasonomanso in the south is estimated to have 329 daily commuters, the three eastern trotro stations account for 607 commuters, compared to the 538 from the three southern trotro stations. Daily commuting levels are much lower from the west since there are only 256 travelling daily for work purposes. Altogether it is estimated that out of the total

of 7,706 passengers from all twelve trotro stations, 2,393 or 28% undertake a daily journey-to-work in Kumasi.

District Planning

One of the most significant influences on planning in the peri-urban areas of Kumasi is the introduction of the new planning system associated with Ghana's decentralisation programme and the associated reform of local government. Ghana has a long history of innovation and practical experimentation with decentralisation since the monolithic district councils created in 1974 under the 'single hierarchy model', based on the Local Administration Act 1971 (Act 359). Its decentralisation programme is intended to transfer functions, powers, means and competence to District Assemblies from Central Government Ministries and Departments. The latest local government reforms, initiated by Local Government Law, 1988 (PNDCL 207), now superseded by Chapter 20 of the 1992 Constitution and replaced by Local Government Act 1993 (Act 462), designate District, Municipal and Metropolitan Assemblies as the administrative, planning, development and rating authorities in their areas of jurisdiction. Although Central Government has retained some powers, including the ability to nominate District Chief Executives as well as additional members to the District Assemblies, Area Councils and Unit Committees, it appears to be a genuine attempt at devolution rather than simply de-concentration, as adopted in many other African countries.

The lack of sufficient trained and experienced professional manpower, limited logistics and insufficient financial resources, however, mean that district planners and policy-makers are still learning how to operate effectively and efficiently. New approaches are required to involve genuine grassroots participation, in which planning is supposed to start from individual community problems, goals & objectives expressed from the Unit Committees, through the Area Councils, to the District Assembly. The new planning system, as set out by the National Development Planning Commission Act 1994 (Act 479) and the National Development Planning (System) Act 1994 (Act 480) is a 'bottom-up' process. This operates through three tiers in a hierarchy - district assemblies, Regional Co-ordinating Councils, and the National Development Planning Commission. The planning system is still being developed, however, so it is too early to judge how far the system is able to overcome past problems. It is intended to avoid past weaknesses, however, which have included 'top-down' planning with its over-centralisation in planning decision-making and implementation, and past marginalisation of the beneficiaries (community and individual) in the development planning process. In the past, too, planning has been handicapped by the lack of political will

and commitment to implement development plans, a lack of effective local level administrative machinery to deal with the critical needs of the communities and the people, and limited or non-existent co-ordination in plan formulation and implementation.

A preliminary assessment of the current difficulties and activities of planning in Kumasi's peri-urban interface is appropriate before consideration can be given to possible changes needed to environmental planning and management in the Kumasi City Region. Strategic planning will be examined first, then physical planning and finally development planning.

Strategic Planning

No strategic regional plan exists for the Greater Kumasi City Region. Consequently, each of the five district assembly areas currently lacks the necessary overall framework within which long-term planning activities can take place. The preparation of a strategic or structure plan covering the entire city region is urgently required.

All five districts contain peri-urban settlements suffering from common problems associated with the growth of Kumasi. These have been found to be associated with urban sprawl and the associated loss of agricultural land for urban activities, together with other land use conflicts over the use of renewable natural resources, such as sand winning or stone quarrying, deforestation, or uncontrolled bush fires. Areas surrounding built up areas suffer from the impacts of water, air and noise pollution, often associated with uncontrolled dumping of solid and liquid waste. In areas undergoing transition, the incidence of poverty may be related to occupational changes or to high levels of in-migration. Inadequate current and future investments in infrastructure services and facilities to meet the basic needs of the growing populations, however, can lead to environmental health problems and deprivation for certain groups or areas due to a poorer quality of life. With increasing population densities, these environmental health problems may be expected to increase in the future due to inadequate planning and protection of domestic water supplies, inadequate environmental sanitation, or insufficient attention being paid to solid waste collection and management. Another manifestation of planning problems observed already is the increase in daily commuting into the centre of Kumasi for employment, commercial or other activities, resulting in unsustainable traffic congestion concentrated along specific radial routes or at key transport nodes.

Provision already exists for collaboration between districts facing common problems since Joint Development Planning Areas may be established by the President as appropriate. The Afram Plains Joint Development Planning Board has been established but for an area of deprivation rather than one undergoing economic and social changes based on urban growth.

The urgent need for strategic planning for the city region has already been recognised locally. One of the programme activities in support of spatial strategies and forward planning in the National Medium-Term Development Plan, 1997-2000 is *"to advise and assist Joint Development Planning Boards for the Greater Accra and Greater Kumasi Development Planning Areas in the implementation and preparation of metropolitan structure plans respectively."*(NDPC, 1997, p.204).

The strategic plan for the Kumasi City Region could adopt the lessons gained in the Greater Accra Development Plan. Ghanaian consultancy expertise should be used wherever possible, assisted by external specialist technical inputs, as required. As in Accra, data and maps from a GIS would be valuable for the planning activities. KUMINFO provides a strong initial starting base or framework around which individual specialist technical analyses and overall co-ordination can be readily incorporated. Approaches for funding a strategic plan might be made to various multilateral agencies like the EU, UNDP, Habitat, World Bank, etc. Bilateral aid agencies may be willing to assist, and it is recommended that DFID Technical Assistance might be sought. Consideration might also be given to initiating a Kumasi Sustainable Cities Programme with the technical or financial assistance of UNCHS (Habitat). Advice on this approach could be sought from the Accra Sustainable Cities Programme.

Physical Planning

A study of district planning and environmental issues by Stephen Buabeng, BIRD, UST, Kumasi, has shown that planning activities are divided between economic or development planning, and physical or town and country planning. The development planners report directly to the Metropolitan or District Planning Co-ordinating Directors, and are part of the Central Administration Department, whereas the Town and Country Planning officers are only members of one of the eleven decentralised district departments (or thirteen in the case of the Metropolitan Assembly). Almost all will have received their professional training together at the same institution (the Department of Planning, University of Science and Technology, Kumasi). Their responsibilities differ, however, and the development planners are perceived as being closer to the centres of power, and deal with financial or budgetary matters, prepare the development plans and help implement, monitor and evaluate the proposed projects. The membership and responsibilities of the Statutory Planning Committees and the Development Planning Sub-Committees of the Metropolitan or District Assemblies in the city region also exhibit substantial differences. The mandatory Development Planning Sub-Committees are larger and are dominated by Assembly members: their average size is 16.5, and between 50% (Ejisu-Juaben) and 75% (Atwima) are elected/nominated Assembly members, suggesting that their emphasis is on discussion and

debate. In contrast, the average size of the five Statutory Planning Committees in the city region is 10.8, but they are dominated by technical officers: Assembly members and traditional authority representatives range between 13% (Ejisu-Juaben) and 36% (Bosomtwe-Atwima-Kwanwoma), and the emphasis appears to be on making and implementing technical development control decisions.

(1) Emphasis on Preparation of Layout Plans:

The National Medium-Term Development Plan has stated that *"town planning processes seem unable to keep pace with the rate of expansion, with the result that rational land use becomes extremely difficult or even impossible. Sustainable economic growth and social improvement are dependent upon effective management of rural and urban land and the integrity of the total environment and eco-system."* (NDPC, 1997, p.212) It also noted that the *"lack of effective land use planning and proper land management has led to land use conflicts and degradation all over the country."* (NDPC, 1997, p.211) These problems are particularly acute in areas undergoing change such as the villages in Kumasi's peri-urban interface.

Staff and resource shortages in all five Metropolitan and District Physical Planning Departments have perhaps forced this concentration on attempting to control development in urban areas, to the neglect of forward planning. The National Plan also recognised this weakness. A comprehensive national human settlements policy is needed, with "*guidelines for the promotion of a hierarchy of settlements and on the types and levels of services required at each hierarchy of settlement"* (NDPC, 1997, p.203). The need for settlement planning is perhaps greatest in the peri-urban areas of Kumasi and other rapidly expanding towns.

Currently, district physical planning officers have concentrated on the preparation of layout plans to make some attempt to guide future land use activities. No technical manuals or guidelines were found to exist on layout plan preparation, however, although use was made of documents on Planning Standards in Ghana even though these tend to focus on larger populations than anticipated in layout plan schemes. A review of these Planning Standards shows that they indicate the basic community facilities required, particularly for neighbourhoods of 5,000 people, or rural villages with populations between 2,000 and 10,000. Many of the settlements in the Kumasi City Region are much smaller than this, although the Planning Standards suggest that smaller settlements could be grouped together and regarded as a neighbourhood providing distances between villages are less than 5 km. Also indicated are land requirements for various types of public facilities, minimum distances of public toilets or water points from the nearest building, road or stream, as well as minimum rights-

of-way for various types of roads, footpaths or power-lines. Quarterly meetings are held for the district physical planners in the Kumasi city region to review and discuss work with the Deputy Director of Town and Country Planning, Ashanti Region, so guidance from more experienced planners is available. Monthly returns of activities are also submitted by the district town and country planning officers.

No register of layout plans was found to exist, so a team of staff from the UST, Kumasi, Department of Planning, led by Dr. Kokor, were asked to identify the layout plans available in the Kumasi Metropolitan Assembly (KMA) and the other four District Assembly Physical Planning Departments. Their 1997 report, An Analysis of Current Planning Processes and Constraints, revealed that by then 134 layout plans had been prepared, 61 in KMA and 73 in the surrounding four districts. Although no information is available for KMA on clients, almost without exception the chiefs in the four district assembly areas were found to be the clients for these layout plans. Although the client is not known in 11 cases, 95% of the other 62 layout plans in these 4 districts were prepared for individual chiefs (56) or queen mothers (3). Single plans only were prepared for the government, or for a landowner. Virtually all these plans were prepared by the district physical planning officers or various officers of the Ashanti Regional Office of the Town and Country Planning Department; only 5 layout plans were identified as being prepared by private surveyors or planning consultants.

(2) The Need for Forward Planning

Improved district physical planning should be more than simply undertaking more layout plan preparations, but might be preceded by some consideration of alternative spatial scenarios to indicate the beneficial or harmful implications of future population distributions, together with some assessment of how better spatial patterns can be achieved. Priorities for layout plans to be prepared, therefore, need to be established according to these assessments about where urbanisation and population increases are desirable and appropriate in the future – i.e. according to the longer-term priorities established by the strategic regional plan. Actions which are short-term or benefit specific groups, or which respond to undesirable market forces, or are simply random events, such as the release of land for non-agricultural purposes by an individual traditional chief, do not fit into the rational planning process, and should not be encouraged.

District physical planners dealing with peri-urban settlements found to be suitable for long-term urban development but beyond those KMA areas covered by recent World Bank-funded aerial photography and map production as part of the Urban II programme are currently handicapped by the absence of large-scale base maps. Special air photographs, or costly and time-consuming ground surveys, will be required to overcome these constraints.

An assessment should be made of the cost and feasibility of producing suitable base maps for layout plan preparations for priority peri-urban settlements using the low cost digital aerial photography funded by another DFID Peri-urban Interface research project. This would provide a very comprehensive and detailed set of baseline data. The costs of conventional air photography and its interpretation plus ground checking, and the cost of conventional surveyors, would need to be compared against the preparation, geo-correction and storage costs of the ADP imagery. The advantages and limitations and applicability of different methodologies should be brought into consideration.

(3) Participatory Land Use and Environmental Planning

Two Participatory Land Use and Environmental Planning pilot projects in Swedru (Kwabre District) and Aburaso (KMA) have made use of these digital village base maps to assist the community to conduct land use surveys, plot village boundaries, and identify sites for facilities needed. A primary objective has been to draw on the villagers' local environmental knowledge and assess the feasibility of involving the communities themselves more fully in village planning exercises which have wider horizons than the preparation of a layout plan within the village.

Greater community participation, with the real involvement of all villagers regardless of social or economic status, has been found to be required in the preparation of village layout plans. Currently, consultations by the planners appear limited, and may be used simply as information-gathering exercises. The district physical planning officers should be encouraged to work closely with the communities and make their technical expertise available to assist them. The KNRMP Participatory Land Use and Environmental Planning pilot projects have shown that this emphasis has been neglected in the past, and that further changes in attitude and approaches among technical officers may still be needed. Community participation does not appear to have been given the prominence expected. More frequent visits to the villages by the planners and assembly-members should be encouraged. Greater consultations and real participation is required at the community level. Greater transparency and a two-way sharing of ideas and information are essential. A technical manual or checklist should be prepared on the issues and considerations which have to be discussed during a village-level participatory land use planning activity. This should help ensure that the community needs, wishes and priorities are fully taken into account.

In addition, maps showing current land use information, as well as the proposed layouts, should be displayed for discussion in the village and copies made more widely available within the community concerned. A current weakness identified by this project is that survey information on existing urban or village land uses have often not been retained or

stored correctly. Village land use maps and layout plan proposals should be carefully stored (within the KUMINFO GIS if possible), and regularly updated when plots are sold and houses completed and occupied. Another weakness identified is that layout plans are not updated, and information is not readily available on land sales or house completions. Establishing a computer-based GIS for villages would provide the necessary basis for monitoring the implementation of village layout plans. This might be extended into land information systems, which could perhaps lead to an improved property tax collection system for district revenues. These problems and opportunities are not unique to peri-urban areas around Kumasi, however. This approach fits into the national proposals on land in the national Medium Term Development Plan. Activities are proposed for the rationalisation of land administration systems, land use and land management for development, and for land data systems (NDPC, 1997, pp.206-210).

Development Planning

(1) Analyses of Recent Medium-Term District Development Plans

One of the main responsibilities of the development planner is to oversee the preparation and implementation of the district development plan. In practice, all of the first Medium Term Development Plans covering the period 1996-2000 for KMA and the four districts were prepared by consultants using information provided by the district assemblies. The Planning Guidelines for the Preparation of Sectoral and District Development Plans, issued in December 1995 by the National Development Planning Commission, were found to have concentrated on the structure of the document rather than the techniques to be used.

At first sight the five Medium-Term District Development Plans for 1996-2000 are thick, impressive documents which culminated in a comprehensive list of projects to be undertaken, showing their estimated costs, phasing, implementing agencies, and contributors. More detailed analyses have revealed a number of flaws in the methodologies adopted. In the District Profile chapters in each of the five District Development Plans, a series of tables summarise socio-economic conditions in the district. No special surveys were conducted for the Kumasi Metropolitan Assembly (KMA) Development Plan. Closer inspection, however, suggests that in the other four districts these tables were based on surveys conducted during a limited time-period, sometimes as little as one week only, so the information has been drawn from only a limited number of respondents. Table 60 below shows the numbers in the various samples, although many of the figures are shown only as percentages of the survey respondents. The farmers sampled, however, represent 0.1% or less of the total estimated

district populations, and the occupational surveys cover only 0.33% or less of the district populations.

Table 60: Number of Respondents in Socio-Economic Surveys

District Assemblies	Farmers	Industries	Occupations	Household incomes
Atwima	127	11	139	167
Bosomtwe-Atwima-Kwanwoma	n/a	n/a	398	155
Ejisu-Juaben	103	45	n/a	n/a
Kwabre	109	55	341	181

Although the surveys are used as if they are representative, no information is provided on the sampling procedures used, so it is impossible to judge whether a statistically significant sample has been used.

Although the district profile chapters all successfully describe the current problems and constraints in a district, and present a series of district goals and objectives to be used in the district development plan, this does not necessarily logically lead into the identification of projects. This may have been due to the fact that in some cases too many goals or objectives have been identified without any clear indication of relative priorities such as rankings, or weighting. The district development plans have been outlined in a Technical Report elsewhere, but the number of goals, objectives, alternative strategies and longer-term outline plans of the districts are summarised in Table 61 below. All districts, except for KMA and Bosomtwe-Atwima-Kwanwoma District have adopted a Project Planning Matrix, modified from the Logical Framework used by DFID and other development agencies. In this the goals, purposes and outputs are listed, but the activities only appear as targets within the Objectively Verifiable Indicators column. These are set out as precise quantitative targets for 91.7% of the indicators in Atwima District (22 out of 24), 80.6% in Ejisu-Juaben (50 out of 62 indicators), and 59.1% in Kwabre District (26 out of 44). Whether it will be possible to use these for monitoring purposes, however, is rather doubtful as they are based on figures derived by planning consultants. In its 1996-2010 Perspective Plan, the other district, Bosomtwe-Atwima-Kwanwoma, also quantifies targets for 54 out of the 89 activities listed (60.7%). Two of the districts identify longer-term objectives or targets in perspective plans for the 15-year period up to 2010 to provide the context for their medium-term five-year district development plans for the years 1996-2000.

Table 61: Numbers of Medium-Term Development Plan Goals, Objectives/Targets, Alternative Strategies, by District Assemblies in Kumasi City Region

District Assemblies	No.of Goals	Objectives/ Targets	Alternative Strategies	Perspective Plan
Atwima	4	24	No	No
Bosomtwe-Atwima-Kwanwoma	8	89	No	Yes
Ejisu-Juaben	24	62	No	No
Kwabre	13	44	Yes	Yes

Almost without exception, it is assumed that existing trends will continue, so the future situations are based on population projections alone, which have limited value for more than a short-term time-period. As these figures are based on the last Ghana Census of Population conducted in 1984, however, the information is already unreliable, and takes no account of net migrations into individual peri-urban areas or villages.

KMA briefly considers alternative scenarios, choosing a Service/Commerce-oriented approach with joint public and private intervention, rather than an Industrial-oriented scenario or a Balanced scenario. The spatial scenario selected is Urban Consolidation, which concentrates on existing built-up areas, with infilling or redevelopment, in preference to the alternative strategy of Expansion of the existing built-up area. Only one of the other districts, Kwabre, very briefly considers alternative strategies; its preferred strategy integrates the two alternatives, a Basic Needs approach or a Production-Oriented approach. None of the four districts introduce any alternative spatial strategies. The identification of future scenarios, showing what the district community wishes to see happen in the future, is missing.

Spatial organisation was seen as an important consideration since a chapter on this appears in each of the four district development plans. Instead of bringing together an integrated approach to analyse spatial distributions of infrastructure facilities and services required to meet the basic needs of current and future populations, however, the analyses have been fragmented into three separate components. These cover settlement hierarchies, the surface accessibility to selected services and facilities, and the population thresholds required to support selected services.

The Scalogram analyses, used by all four rural districts, displays services (columns) found in each village (rows) in a matrix. The technique seems particularly unhelpful since each of the four districts was found to include a different set of services or functions, not all villages or recognised communities are included, and some activities are not public sector responsibilities. Atwima displays 41 functions for 37 communities, Bosomtwe shows 33 services for 22 settlements, Ejisu-Juaben 31 for 31 communities, and Kwabre has 35

functions for 25 communities. Out of the 68 functions or facilities/services listed in the four districts, only 15 appear in all districts, 8 are common to three districts, 11 are shown for two districts only, but 34 appear in a single district only. No weightings of the importance of an activity are introduced, and higher-order and lower-order functions for the same service are mixed together, resulting in double-counting. An artificial scoring system, biased towards the absence of particular functions, is then introduced to classify villages into a hierarchy of settlements. This means that the total number of villages containing a particular function is divided into 100 (labelled as total centrality) to produce a score for that function/service; for example if all 31 villages included in a district have primary schools, the score for primary schools would be 3.2, but for the district headquarters, of which there could only be one, a score of 100 would be assigned. The scores for each function present are then totalled for each town/village and called the Total Centrality Index, which is then used to classify villages into different levels of a hierarchy. No indication is given of what services and infrastructure facilities ought to be expected at each level of the settlement hierarchy. The calculations are based on the assumption that population-size alone is the criteria to be considered, neglecting the requirement to cluster populations of smaller communities into a larger unit with centrally-provided infrastructure, or that proximity to services provided in neighbouring settlements, or even other districts, should be taken into account.

Surface accessibility assumes that there are maximum acceptable travelling times for different services under conditions of high, medium or low accessibility, and converts these into distances on major roads, minor roads or footpaths according to assumed speeds of travel on the different types of roads. The four different districts do not always consider the same services, or use different assumptions about speeds on different surfaces. Although these acceptable walking times or vehicle correctly observe that vehicle travel times vary according to different road surfaces, and that different waiting times are required for transport services on different categories of roads. The misleading overall impression provided in the resulting maps is that districts are well provided with the selected types of facilities chosen for the analyses, since few villages or areas are inaccessible by some sort of road. Vehicle accessibility actually depends on access to a car or the ability to pay trotro or taxi fares, as well as appropriate minibus or trotro routes connecting a village to the centre where a service or facility is located. Deprived or low income groups would be concerned with walking distances and times to reach the facilities, as they would be unlikely to afford vehicle fares. These analyses would have been more meaningful if simply confined to reasonable walking times or distances to the facilities or services.

Similarly, the threshold analyses of the populations required to support different levels of infrastructure and services contains plausible elements, but until small communities

within 5 km of each other are clustered into units of 5,000 population, as suggested by the Ghanaian Planning Standards documents, then the analyses are flawed.

Currently an incomplete picture of spatial processes is presented in each of the districts. What is missing is a more focussed, closely-integrated application of spatial analysis techniques in which planners draw upon the views expressed by the communities and assess what is required to happen in the future. A vision of the future among the planners in the urban and peri-urban areas may be more helpful than relying on a simplistic number-crunching or projection approach based only on present trends.

(2) Community participation

Community participation was a major requirement in the preparation of the district development 5-year Medium Term Plans (1996-2000). The national Plan Preparation Guidelines required all district and metropolitan Assemblies to actively involve the communities and interest groups in the planning process from plan formulation to implementation stages. As shown in the Specialist Report, Analysis of Current Planning Processes and Constraints, prepared by Dr. Kokor and his team from the Planning Department, UST, Kumasi, community participation has taken different forms in the preparation of plans by the districts in the Greater Kumasi City Region.

In the Kumasi Metropolitan Assembly (KMA), the plan was prepared by a team of consultants together with a counterpart team of KMA officers. Key departments were requested by the DPCU (Planning Unit) to submit their programmes covering the 5 year period. Secondly, the team of consultants requested each Metropolitan Assembly member to state the problems, needs and requirements of their electoral area, based on local meetings organised by the assembly member for this purpose. In addition, the consultants had constant meetings and discussions with their counterparts. Draft proposals were discussed by the consultants, counterpart team members and assembly members, resulting in a final draft report. Comments received on the draft report were incorporated into the final plan by the consultants. Many assembly members, though, did not appear to hold the proposed meetings in the communities to identify local problems and needs. More importantly, the main priorities and roles that communities/local people in the electoral areas were willing and able to play was neglected. Another weakness was the limited role played by the metropolitan assembly members in setting the main priorities to see if they matched projected resources.

For Atwima District, community participation was initiated by a workshop in the district capital, based on "Goal Oriented Programme Planning" (GOPP), which involved all the assembly members, heads of departments, opinion leaders, chiefs and others. Development

problems and their inter-relationships were discussed, and district assembly objectives identified and structured through the use of problem and objective trees. A survey into social, economic, natural resources, environmental and institutional issues was conducted, with the data used to both validate and complement the output of the GOPP workshop. A further participatory Planning and Programming Workshop was then organised to evolve a list of feasible goals and related objectives, identify development programmes and projects, formulate action plans, and identify possible sources of funding. The strength of this approach was that during the final approval process by the District Assembly, a great majority of them identified themselves with the plan and were anxious to see it being implemented. The process was very slow and time-consuming, however, and the capacity of existing District Assembly staff to implement and manage the plan proposals was never seriously considered.

In Bosomtwe-Atwima-Kwanwoma District, the baseline survey to collect basic information about its current development status was heavily emphasised. Assembly members were, however, involved in the identification of the development problems and resource potentials of the district, the basis on which the plan was formulated. A draft copy of the plan was reviewed by the development planning sub-committee of the Assembly before final approval by the general Assembly. Inadequate interaction took place with the people during the process of plan preparation by the consultants.

There is no indication in Ejisu-Juaben District that local community members were involved in the plan preparation process, although they were expected to be involved in the implementation of the plan proposals. It is unlikely that people not involved in formulating plan proposals, and so without a sense of ownership of a plan, could actively participate in its implementation.

After conducting a reconnaissance survey of Kwabre District, the team of consultants presented the results of socio-economic and institutional surveys for comments and corrections at a meeting attended by 55 assembly members, the Development Planning Sub-Committee members, and 18 departmental heads. A Committee of the District Assembly was constituted to liaise with the team of consultants to discuss the final output. After reaching a consensus on proposed projects/activities, the Development Planning officer assisted the team to re-organise projects/activities to ensure that the District Assembly would be capable of implementing the proposed projects. The District Assembly had no opportunity to see the final output.

(3) Absence of Databases and Maps

The district economic development planners were found to lack information about the villages and on the spatial distributions of facilities and services within their districts, and so have been handicapped in proposing where resources should be allocated, or in identifying

priorities in tackling environmental and other problems. Planning officers have had to rely on various types of manual records held in other district departments. If information is not available within the district assembly departments, it has to be sought from a variety of sources, including ministries, area councils, unit committees, chiefs, opinion leaders, churches, youth associations, non-governmental organisations. No databases were found to exist in the four districts, and computers have only recently been obtained within the past year or so, coincident with the opening of new administrative office buildings in each of the district assembly headquarters. Information is rarely available on maps at appropriate scales. The absence of databases for district planning has been identified as a major constraint handicapping more efficient plan preparation and implementation. The universal use of planning consultants for the 1996-2000 Medium Term District Development Plans has meant that databases are not readily available for the next district development planning exercise, leading to unnecessary duplication of effort and delays in making planning decisions. Consequently, it was concluded that greater use of maps, databases and spatial analyses are urgently required to strengthen district development planning in Kumasi's peri-urban areas.

An August 1997 Workshop initiated KNRMP's efforts to overcome this weakness. The district economic and physical planners, together with specialists from the Regional Co-ordinating Council, Environmental Protection Agency, identified the roles of the district in natural resources. As shown in Table 62, this covered land, water, timber, non-timber forest products, fish, sand and stone, refuse/waste disposal. They also suggested the information required, available and needed, and possible sources of information.

Table 62: Natural Resource Information Needs identified by District Planners, Aug. 1997

Resource	Role of District	Information Required	Information needed	Possible information sources
Land	Preparation of structure plan; Land administration; Development & control of human settlements; Enforce regulations on land use; Preservation of nature reserves	Base maps (1:2,500); Population data; Land areas; Land use inventory (including facilities); Natural Resource inventory (including watersheds); Housing stock; Land ownership	Land ownership; Housing stock; Land suitability; Land potential; Population; Soil quality; Land use; NR inventory	Land Evaluation Board; Land Title; District Revenue Records; Surveys Department; Town & Country Planning; Soils Research Institute, Universities; Ministry of Agriculture; Lands Commission

Water	Protection of streams & watercourses; Water quality; Water provision	Sources of pollution; Whole watershed/ extent of water bodies; Waste disposal sites; Extent of pollution; Water-borne diseases; People affected downstream	Sources of pollution; Watershed information; Dispersal of waste; Extent of pollution; Water borne diseases	Environmental Protection Agency; KMA Waste Department; UST Civil Engineering; Clinics; Chiefs; District Authorities; CSIR - WRRI
Timber	Conservation & protection; Collection of royalties & fees	Types of timber species; Coverage of forest reserves; Rate of exploitation; Timber concessions	Species; Coverage, Timber concessions; Rate of exploitation	Forestry Research Institute; FIBP; Forestry Department; Ghana Timber Board
Non-timber forest goods	Encourage schools, communities to establish woodlots; Encourage snail & mushroom farms; Control exploitation of game (closed season); Collection of permit fees; Organise herbalists	Type of suitable species for woodlots & other NTFPs; Number, names & location of herbalists; Rate of exploitation of NTFPs; Inventory of medicinal herbs	Suitable species, Inventory; Rate of exploitation	Herbalists Association; Department of Game and Wildlife; Forestry Department; Institute of Science and Technology
Fish	Encourage fish farms; Preservation - discourage use of pesticides	Type & quantity of fish (resource base); Fishing practices;	Species; Resources; Practices	Fisheries Department; Universities
Sand and Stone	Conservation & environmental sustainability; Collection of permit fees	Identify winning sites; Identify sand & stone contractors; Current & future demand; Negative impacts of sand winning	Winning sites; Contractors; Demand; Impact	Mineral Commission; Mines Department; Environmental Protection Agency; Town & Country Planning; Sand & Stone Association
Refuse & waste disposal	Ensuring proper & safe disposal; Waste Management Encourage organised disposal; Collect fees for waste collection; Encourage privatisation of waste services	Housing stock; Access roads; Type & volume of waste; Identify disposal sites; Identify collection points; Criteria for selection of disposal sites	Housing; Access roads; Type & volume: Disposal sites; Collection sites,	KMA, District Environmental Health Officers.

A further Workshop on Information Needed for Planning was held for all planners in the city region in September 1998. Selected maps from the Village Characterisation Survey were produced using KUMINFO and displayed in order to demonstrate the capabilities of KUMINFO and the practical applications of computer maps for planning. The district planners then agreed to provide village-based information for selected aspects to extend similar maps to the rest of their districts. Given the requirements of the forthcoming medium-term district development planning exercise, however, the information needed by the planners extended beyond environmental information or data on renewable natural resources, but also included social and economic infrastructure. By December 1998, a wide list of information

had been drawn up in the UK and circulated to the planners for comments as part of the liaison work of Stephen Buabeng, the counterpart regional planner. A final list of information that the planners considered to be both useful for them as well as feasible to collect was then produced.

A set of 24 tables was drawn up so the planners could enter the names of the recognised communities (towns and villages) and provide information in the appropriate columns. This was accompanied by a set of detailed guidelines on what information to include. As a by-product, it was hoped that by initiating this data collection exercise, the planners would be able to develop closer links with other district departments and with the communities by obtaining village information from the district assembly members and other local key informants. In a further Workshop for the planners in August 1999, data for Kwabre District, the first district to provide a complete set of hand-written tables, was entered into computer databases and maps produced in KUMINFO using ArcView GIS software. This database consisted of 146 variables for 86 recognised communities. Selected variables were displayed to the planners to demonstrate how the information might be used for planning in order to motivate and encourage the other districts to complete this exercise and provide information which could be mapped for their district as well as for the city region. Subsequently, maps have been designed and a set of specifications drawn up for 40 maps within KUMINFO.

The project has now created databases of information needed for planning for each of the four districts. Updating and advice on using KUMINFO is available at a central point through the Data Manager in the Institute of Renewable Natural Resources, UST, Kumasi. ArcExplorer, a simplified free version of the software, is being provided on each district's computer so that the district planners can undertake further research and analysis, including the production of their own maps.

The preparation of tables and guidelines on village-level information needed for planning, and the provision of support, advice and assistance has encouraged the district assembly planners to provide data. KNRMP has been able to ensure, at a relatively low data-capture cost, that appropriate databases and maps are now readily available to assist the district planners. Continued efforts will be needed, however, to update, refine and extend these district databases and maps, and make effective practical use of this material. In particular, the exercise should be completed by adding geo-coded data for the peri-urban and urban areas of KMA. The forthcoming population census for the year 2000 should be incorporated into these analyses as soon as possible. As a result of this work, KUMINFO already provides a valuable GIS resource, and could be immediately utilised as the basic framework for the preparation of a Strategic Plan for the Kumasi City Region.

(4) Planning Activities of Selected Unit Committees

Although the District Assembly is the basic unit and the highest political and administrative authority in a district, unit committees have been established as the lowest tier of government at the very grassroots level. They cover settlements or groups of settlements in rural areas with populations between 500-1,000, and neighbourhoods of urban areas with populations of 1,500, and have major roles in mobilisation for popular participation, consultation and implementation, rates collection, data collection and enforcement of rules and regulations. They have taken over the functions formerly performed by the Town or Village Development Committees, and are also responsible for environmental cleanliness, community education on social issues, registration of Births and Deaths, and supervision of district assembly staff assigned duties in their area. They also assist Town or Urban Councils in keeping records of rateable persons and properties and with revenue collection. Their main activities are the mobilisation of community members for self-help projects and the implementation and monitoring of self-help and development projects.

Unit Committees are composed of ten members elected on a non-party basis in 1998, plus five members nominated by the District Chief Executive. It was found that in the Kumasi City Region there are 952 Unit Committees - 403 within KMA, 216 in Atwima District, 124 in Bosomtwe-Atwima-Kwanwoma District, 64 in Ejisu-Juaben District, and 145 in Kwabre District. They report through their District Assembly-member to one of the 41 Area Councils, or 22 Town or Sub-Metro Councils within KMA, and then to the District Assemblies. The responsibilities of the unit committees or area councils in relation to the district assembly are not yet clearly identified, though, so the intended two-way flow of ideas and information is not always being achieved. Although the unit committees have no sub-committees, in practice all are concerned with development planning since project initiation starts from the unit committee or village level. Unit committees meet at least once a month, and aim to make decisions by achieving a consensus on issues. Annual community meetings are convened, however, so that project initiation may come from a variety of sources, including community members themselves, unit committee members, Area Council or District Assembly members, departmental District Assembly officers, outside donors, etc.

Since insufficient knowledge exists on the development planning activities of unit committees in the Kumasi City Region, a special study was conducted in a sample of 30 unit committees; 6 unit committees were selected in Kwabre District and samples of 8 in each of the other three districts to determine their priority developments and their current development activities. In total eighty-two priority developments were reported in the 30 unit committees, which were engaged in 56 current activities. At first sight most of the priority

developments appeared to be concerned with social infrastructure activities since 21 priorities are related to education and 4 to health, and only 3 or 3.7% of the priority developments could be classed as environmental. If water, sanitation, toilets and street drains are defined as indirectly affecting the quality of the environment and environmental health, however, over 43% or 36 of the total listed priority developments are actually concerned with environmental issues. Of the remaining priority developments, 7 are related to the construction of markets, 5 are for electricity, 3 to road rehabilitation, and 4 aim to increase employment and incomes (2 cassava processing factories, a craft village, and a tourist village).

Among the 56 current activities, the 21 education projects are the largest single category, but 24 or 43% are concerned with environmental issues. Water (7), toilets (4), and street drains (3) account for much of this emphasis, although 10 or 18% focus directly on the environment. These include environmental education projects, 2 tree planting activities, refuse dump clearance, environmental cleanliness, erosion control, river reclamation, environmental and sanitation control, renovation of the area, and clearing/burning village surrounds. Of the other projects, six committees stated that they are concerned with mobilising funds, organising voluntary organisations or the formation of industrial work groups/associations, but three are providing poles for electricity projects, two are building cassava processing factories, or markets, or community centres. Individual unit committees are constructing a community clinic, or renovating a community library.

Community self-help projects organised by the unit committees in this sample of committees known to be active are clearly concerned with small-scale environmental projects which can be handled by self-help communal labour and do not require large amounts of capital or technical expertise. A few are concerned with employment creation, but the largest single category is construction of schools, day care centres, or other activities concerned with education. Only a few are health projects, perhaps because staffing and drugs would be more significant than simply building a community health facility.

(5) Institutional Linkages

A major weakness has been identified as the limited integration and co-ordination of policy making which has been taking place, both among the different departments of the same district assembly as well as between neighbouring district assemblies. Closer links need to be developed both within and between districts if improved integration and co-ordination is to be achieved. Greater co-ordination of policy-making is essential, and priority should be given to developing improving management and integration of planning and other policy making between the various levels of government.

Limited use also appears to have been made of partnerships between the public sector and the private sector, including the voluntary sector. Particular attention appears to be required to foster these partnerships and develop closer links between the district assemblies and non-governmental organisations and community-based organisations. The recent district development plans all place great reliance on the voluntary sector to implement many of the proposed projects, even though these voluntary organisations or the various community members do not appear to have been closely involved in the identification of these projects. Environmental organisations or pressure groups do not appear to be playing as active a partnership role as needed, so some active promotion or assistance and training might be required to help overcome this gap.

With the exception of KMA, and Atwima District, however, no environmental NGOs were found to be operating in the Kumasi City Region. In Atwima District, the only NGO operating there is the Rural Development Youth Association and its main focus of operations is afforestation. Within KMA, eight environmental NGOs are found to be operating in various fields. These include the Friends of River and Water Bodies, Environcare, Friends of the Earth, Green Forum, Environmental Protection Association of Ghana, Wildlife Club, Ashanti Regional Tree Growers Association, and the Sanitation and Decongestion Task Force. This reflects the generally limited activities of NGOs noted in each of the 1996-2000 District Development Plans. In Atwima District only the 31st December Womens Movement, and the Enterprises Development were active. In Bosomtwe-Atwima-Kwanwoma, District the Adventist Development and Relief Agency (ADRA), World Vision International, and the Catholic Relief Service, together with socio-political organisations (Association of Committees for the Defence of the Revolution - ACDR, 31st December Women's Movement), as well as orthodox and Pentecostal churches, and youth groups, were active, particularly for the provision of boreholes and school buildings. In Ejisu-Juaben District, the only three NGOs identified were involved in health (Save the Children Fund) or agricultural extension (Technoserve and Global 2000). In Kwabre District, a few projects have been provided in some few selected communities by 31st December Women's Movement, the Canadian International Development Agency (CIDA), and ADRA.

Although the responsibilities of the unit committees or area councils in relation to the district assembly are not yet clearly developed, a two-way flow of ideas, information and priorities, will be essential for successful plan preparation and project implementation in the future. Despite the limited manpower, logistics and resources handicapping the activities of the district technical officers, district assembly staff and assembly members should be encouraged to work closely with grassroots organisations like the unit committees. Effective mechanisms must be found for readily providing guidance and advice on technical matters,

and for giving priority to responding to community problems, wishes and priorities expressed through real and effective community participation in planning and policy making.

Land sales in peri-urban areas appear to have resulted in the declining influence of the chief due to the loss or decline in incomes of indigenous farmers and the in-migration of strangers into new houses. Nevertheless, the traditional chiefs still have an important role to play in helping to ensure that the village environment is cleaned on the taboo or non-farming days. Currently, a proportion of the 'drinks money' from the sale of land rarely appears to be used for financing plan preparations, environmental improvements or the infrastructure facilities and services needed by the village communities. If these funds are made available for the community, however, account needs to be taken of facilities and services already available or proposed in accessible neighbouring communities. District planning officers have a responsibility to engage in forward planning and make appropriate information available to grassroots decision-makers so that scarce resources are not wasted. To avoid the danger of the proliferation of unsustainable or under-used facilities and services, whether to overcome neglected provisions in the past or to meet additional pressures created by the occupants of the new housing, technical advice on the location of facilities will be required.

The Ashanti Regional Office of the Environmental Protection Agency, the Ashanti Regional Co-ordinating Council and other regional/national bodies have a crucial role to play in environmental and renewable natural resource issues. They should take the lead in advising the district assemblies and individual communities on the level of protection needed for the natural and built environment. While continuing to offer guidance on how best to incorporate environmental improvements to protect natural resources, they might also contribute towards overcoming environmental health problems.

(6) Planning Recommendations

Currently, various specialist officers of the district assemblies do not always appear to function as part of an integrated team. Methods should be identified to break down specialist professional isolation. District planning teams, for example, tend to be biased towards economic planning, but could utilise more fully the skills and knowledge of both the physical planning officers, as well as the policy-making and implementation skills of other specialist departmental heads. The preparation of the next district development plan by district assemblies themselves instead of by external consultants would help foster integration and co-ordination and develop these closer linkages. Specialist sub-committees might be convened to undertake responsibility for key sectors in the development plan. If local outside consultants have to be used again for the 2001-2005 plans, the various district assembly departments, together with district assembly members, would be expected to provide a greater

supervisory role in the plan preparation exercises. Officer/member working groups could do more to provide appropriate information, assess relative priorities, ensure that greater and more effective efforts are made with community participation, and undertake greater monitoring and evaluation of the impacts and effectiveness of plan proposals.

There is a danger that in the past peri-urban areas have been starved of resources and infrastructure facilities/services due to their proximity to the national-level higher-order function in the core city under a centralised decision-making system. Further investigations should be conducted to test whether evidence exists that such a concentration of resources on the centre of the city region has led to the relative neglect of peri-urban areas in the Kumasi City Region. The lack of an integrated regional approach towards the provision of infrastructure and services covering the urban and peri-urban areas may mean that basic services in the peripheral areas are not provided or operate ineffectively, resulting in problems of excess pressure on higher-order services in the central area. Additional population growth in the peri-urban areas may be making this situation worse.

Currently the planning systems in the peri-urban areas of Kumasi appear simply to react to events, perhaps even ignoring the patterns and processes of change, and do not appear to be proactive enough. A much more proactive form of planning would enable the full implications of urban developments to be taken into account. The reality is that the decisions about where urbanisation takes place are not being made by planners, but are left to an indirect form of market forces in which individual village chiefs decide when and where land will be converted from agriculture to housing or other urban activities. This may require a city-region partnership to be developed between the Asantehene's Office, the Land Commission, the various district assembly planners and assembly members, and the communities themselves, to impose some order to the land release process rather than leaving this to the individual village chiefs. Urban development results in increased commuting patterns, with resultant increases in transport movements to Kumasi. Some of the radial routes have better capacities for handling increased trotro flows than other roads and these need to be taken into account in settlement planning at the city-region scale. Otherwise, the end result will be an unsustainable city region with dramatically increased levels of urban traffic congestion with its associated disadvantages of increased pollution, accidents, noise, higher transport costs, etc. Improved traffic management schemes may be costly to implement so that consideration may need to be given towards introducing conventional bus services to handle the increased flows of people into and out of the city. In addition to the capital costs of acquiring and maintaining buses, this has serious implications for the substantial levels of employment currently provided by trotro and taxi operators, and the loss of investment opportunities and returns to the owners of these vehicles.

Under a more proactive planning system, priorities would be placed on the provision of infrastructure facilities and services where they are most needed. Inevitably, some villages would become more attractive than others, so that further increased demands for housing and urban services would be expected there, leading in turn to greater population in-migrations, growth and commuting. Unless carefully considered at least 15 - 20 years in advance, these enlarged communities might be expected to exhibit breakdowns in social structures, and the concentration of environmental problems. The National Medium-Term Development Plan also recognises these weaknesses, including the absence of a national human settlements strategy, the lack of structure (or strategic) plans and the failure to update the existing plans in a systematic way. Among other major issues and constraints are the lack of co-ordination between land use and transportation policies, ineffective co-ordinating machinery in the planning, funding, development, management and maintenance of economic and social services and infrastructure, and development plans with unrealistic funding expected from the public and private sectors. It also notes the lack of human and institutional capacity to plan and manage the growth of human settlements. Consequently, many of the proposed activities include the preparation of a variety of guidelines and technical manuals within the proposed four human settlement programmes. These are the National Spatial Strategies and Forward Planning of Districts and Settlements, the Administration and Management of the Development Process, Human Resources for Planning and Development, and Rural and Urban Shelter.

Environmental Planning

Environmental Problems within the city region

Workshops were organised by the Environmental Protection Agency in each of the regions in 1996. These were attended by three key people from each of the district assemblies, the Presiding Member, the District Environmental Management Committee Chairperson, and the District Co-ordinating Director. As part of an exercise on Environmental Local Action Plans on Compliance Enforcement, they had been asked to consult other District Environmental Management Committee members to identify environmental problems in their district, prioritise the two main issues, with their causes, effects and interventions required. The environmental problems for each of the five districts in the Kumasi City Region are listed in Table 63.

Table 63: Environmental Problems Identified by District Environmental Management Committees, 1996

Kumasi Metropolitan Assembly	Atwima	Bosomtwe-Atwima-Kwanwoma	Ejisu-Juaben	Kwabre
1. Accumulation of solid waste at Waste Transfer station	1. Bush fires	1. Sand winning & Stone quarrying	1. Indiscriminate tree felling	1. Sand winning & Stone quarrying
2. Air Pollution	2. Illegal timber felling	2. Bush fires	2. Illegal sand winning	2. Bush fires
Indiscriminate dumping of refuse elsewhere	Sand winning	Timber operations	Illegal mining (galamsey)	Timber operations
Water Pollution	Quarrying	Soil erosion	Water pollution	Soil erosion
Indiscriminate disposal of scraps at Suame	Mining	Charcoal burning	Bush fires	Charcoal burning
Unauthorised structures		Water pollution		Water pollution
Overgrown weeds on undeveloped plots		Bad farming practices		Bad farming practices
Noise pollution				
Farming along water bodies				

Source: Environmental Protection Agency (1996*) Report on Trainers' Workshop for District Environmental Management Committees of District Assemblies of Ghana.*

In the specialist report on planning processes, prepared by J. Kokor and his team in 1997, the environmental problems included in the 1996-2000 Medium-Term District Development Plans are summarised. These are deforestation, poor waste management, water and air pollution, settlement erosion, poor water management, together with more localised issues (illegal mining, noise and air pollution, and liquid waste). They also list the proposals in each plan designed to tackle these environmental problems. In their summary of the Ashanti Region Harmonisation Report, prepared by the Regional Co-ordinating Council (RCC), the environmental development problems arising from inappropriate and uncontrolled exploitation of natural resources are noted. The constraints are seen as inadequate resources, inadequate personnel/logistics, the low level of environmental awareness, the low level of fines on offenders, and inadequate or inappropriate dumping sites. Each district's proposals on land and forest management, waste management and pollution are listed in this report, together with the RCC's recommendations on additional actions needed by each district. Settlement planning was seen as a weakness in all districts; in particular, the peri-urban areas of Kumasi suffer from haphazard developments and the absence of layout plans in rapidly-growing settlements. The district headquarters, especially, need new or updated layout plans, land acquisition costs need to be considered, and public education on the importance of planning is required.

A more recent study by Stephen Buabeng has identified the perceptions of environmental problems among the district planners. While containing many similarities to the earlier DEMC lists, additional problems are noted. These include water course destruction

in KMA, poultry manure disposal, air pollution from poultry manure, land degradation and poor waste management in Atwima, poor waste management in Ejisu-Juaben, poor waste management and inadequate development control in Kwabre District. The Environmental Protection Agency is currently engaged in the preparation of District Environmental Profiles. After presenting concise summaries of the biophysical environment and the socio-economic environment (population parameters, economic activities, infrastructure), they list the main environmental problems and their causes, and the initiatives. So far, preliminary profiles have been prepared by KMA and Atwima District only. Here again, however, different environmental problems are mentioned. In KMA, for example, the environmental problems are given as browning of the environment, devegetation, (both appearing for the first time) as well as noise pollution, and air pollution. In Atwima District, deforestation and sand winning also appear, but water pollution and poor sanitation are environmental problems not raised elsewhere for this district. Consequently, no clear consensus or similar priority-order appears to be emerging among the various examinations of district environmental problems.

Limited emphasis on implementing environmental projects

In their first Medium Term Development Plans, 1996-2000, the five district assemblies, have adopted the main themes from Ghana-Vision 2020 (The First Step: 1996-2000) - human development; economic growth; rural development; infrastructure; and an enabling environment. Consequently, environmental issues are fragmented among these different themes, so are not being given their due prominence. Project proposals for improved domestic water supplies, environmental sanitation, or health facilities, for example, may be shown under different themes in various districts or even appear under several of these themes.

Despite statements on the importance of environmental issues in the development plans of the five district assemblies making up the Greater Kumasi City Region, out of the total estimated proposed expenditures of 194,347 million cedis, only 6,826 million cedis (3.5%) are devoted to environmental projects. Out of the 1,838 projects listed for the city region, only 16.8% or 308 projects are classed as environmental projects.

People's perceptions of the environment within villages means that low priorities may often be placed on environmental problems compared to other issues such as employment creation, gender issues, infrastructure needs, etc. Education is needed into the inter-related nature of activities, problems and constraints in peri-urban areas. For example, poor quality of drinking water may lead to health problems, reducing the ability of affected persons to

work, resulting eventually in low incomes and poverty. More information needs to be provided to villagers so that they appreciate the importance of the environment to their quality of life and well-being. Community awareness also needs to be promoted into the advantages provided by improved planning activities. Environmental considerations tend to be neglected or given insufficient practical attention in district development planning, development control and forward planning activities in each of the districts in the Kumasi city region. If long-term sustainability is to be achieved, greater attention will need to be given to environmental issues. At the national level, the significance of environmental issues for human settlements has been recognised in the National Medium-Term Development Plan. Four leading programmes are proposed - natural resource management, management of the built environment, waste management, and environmental education, each requiring various technical manuals to be prepared to advise local planning authorities.

District and Community Environment Committees

Although District Environmental Sub-Committees are not mandatory, the survey by Stephen Buabeng found that KMA and all four districts in the Kumasi City Region have established Environmental Sub-Committees. The only other non-mandatory sub-committees are Education Sub-Committees in two districts (Ejisu-Juaben and Kwabre), and Agriculture or Public Relations Sub-Committees (both in Kwabre District). Environmental Sub-Committees are large, however, and dominated by elected or nominated Assembly members, a possible indication that these committees might simply discuss environmental matters and not be effective. The average size is 15.8 members, ranging between 8 and 20 members. Elected/nominated Assembly members make up at least half of the membership in all districts, rising to 90% in KMA. Technical inputs are dominated by health considerations, however, since the Head of the Environmental Health Division, District Health Department, is a member in three districts and the District Medical Officer of Health is present in another district. District Environmental Officers are members of only two District Environmental Sub-Committees (Ejisu-Juaben and Kwabre), joined by an Environmental Protection Agency officer in both districts. The District Development Planning Officer is a member of none of the five Environmental Sub-Committees, although the District Co-ordinating Director and the District Chief Executive are members of one sub-committee (Kwabre). The Town and Country Planning Officer is a member only in Kwabre District.

As early as 1992, the Environmental Protection Council produced Guidelines on Environmental Management for the District Assemblies. These proposed that District Environmental Management Committees should consist of 15 members, five of whom would

be Assembly members, at least two of whom would be women, plus another representative of the National Council on Women and Development; there would also be two representatives of environmental non-governmental organisations. The five district technical officers would include the Town and Country Planning officer, Parks and Gardens officer (now also part of the Physical Planning Department), Medical Officer of Health, Waste Management, and Education officers. In addition, regional agencies included as members would be the Environmental Protection Agency, and Ghana Water and Sewage Corporation. The current reality is that all include more Assembly members than proposed. None of the five districts include representatives of environmental NGOs or the women's council, only two of them include the regional EPA, only one district includes its Town and Country Planning officer, and none include education or waste management officers. EPA is encouraging the appointment of Environmental Officers, but none of the districts examined have been able to make appointments so far. In contrast, all include a Health Department representative, usually the Environmental Health Officer. Among the functions of the Environmental Sub-Committees are land use planning and management, development control, and management of natural and man-made environments, yet the current compositions of these sub-committees suggest that the members do not have the technical capacities to deal with these functions.

It had been recommended that District Environmental Management Committees would prepare local resource and land use plans and strategies for their sustainable utilisation, and would plan and recommend strategies for the improvement of, or protection of, the environment, especially fragile or sensitive ecosystems. They would also monitor the environmental effects of major development projects, obtain local community reactions to environmental impact assessments (EIAs), and review and update bye-laws for the maintenance of a sound environment (noise, sanitation, land use, tree planting, bush fires, etc.). In addition to formulating strategies for creating environmental awareness within the district, they were expected to promote and provide guidance for the establishment of community level Environmental Committees. Community Environmental Committees were to be chaired by the Chief of the village, and would include the Chairman of the Village Development Committee, the District Assembly member representing the community (or their appointee if the member does not come from the community), and a representative of the Area Council. Also included would be two representatives of local environmental non-governmental organisations, one from women's organisational groups, one from the Anti-Bush Fire Squad, together with one other citizen appointed by the Village Chief. The Guidelines suggest that Community Environmental Committees will be the organs through which the environmental programmes of the District Assemblies will be carried out at the community level. They provided a list of twenty-six responsibilities for them.

Investigations within the five districts by Stephen Buabeng, however, found that no Community Environmental Committees are in existence. This appears to be a typical gap in Ghana, however, since the headquarters of the Environmental Protection Agency were unable to identify any districts within Ghana where community environmental committees are operating. The districts in the Kumasi city region were found to be unaware of these guidelines, and also lacked the necessary human resources and technical expertise to be able to provide guidance to the communities; none of the five districts have recruited district Environmental Officers, but still rely on the under-staffed Ashanti Regional Office of the Environmental Protection Agency for advice. In addition, none of the unit committees have formed any sub-committees. Nevertheless, as noted earlier, the development priorities and current activities of the sample of unit committees suggest that environmental issues are not being neglected. The definitions of environmental issues should not be confined solely to the use of natural resources, environmental protection or conservation of the ecosystem, however, but need to cover aspects directly or indirectly related to environmental health, such as domestic drinking water, sanitation, street drains and solid waste collection or disposal. These activities, which contribute to the maintenance of public health, are seen as complementing health policy planning and the provision of primary health care services within districts.

Village Health Committees were found to have been established by the Environmental Health Division of the District Health Management Team in 39 communities in the Ejisu-Juaben District Assembly area only. In the other three district assembly areas, Water and Sanitation Committees (WATSAN's) have been established by District Water and Sanitation Division Teams to take care of water and sanitation facilities being provided by the Community Water and Sanitation Division of the Ghana Water and Sewerage Corporation. These only operate in those communities benefiting from the Corporation's activities, however.

The Environmental Sub-Committees would be expected to work closely with the District Development Planning Officer to identify communities which currently lack adequate water supplies. The Unit Committees would be expected to play a key role in this by helping to bring water supply problems to the attention of the Area Councils and District Assemblies. Future investment priorities should be given to villages either currently lacking adequate capacities of protected domestic water supplies (boreholes and wells), or which have deficiencies in the management or maintenance of their water supplies, or which are forced to have seasonal reliance on untreated water collected from streams and ponds. These project priorities must also take into account the future populations to be served, however, and if inadequate resources or insufficient physical capacities exist for the provision of safe drinking water, future population expansions in these communities should be discouraged. The

provision of treated, piped water supplies throughout the peri-urban areas should be treated as the long-term priority.

Environmental Sanitation

District Assemblies and Unit Committees are expected to play a key role in implementing the National Environmental Sanitation Policy, announced by the Ministry of Local Government and Rural Development in May, 1999. In addition to conserving natural resources and maintaining pleasant surroundings, district assemblies are also responsible for managing and protecting the environment to prevent hazards to human health. A National Environmental Sanitation Policy Co-ordination Council is to be established, and an Environmental Health and Sanitation Unit set up within the Ministry of Local Government and Rural Development to engage in sector planning, and provide technical assistance and training to district assemblies and service providers.

District Assembly Health Departments will carry out four distinct functions:

1. Waste Management - Central government or agency staff, responsibilities and budgets are to be transferred to Waste Management Departments of the Metropolitan Assemblies, or to Environmental Sanitation Divisions in the District Assemblies;

2. Public Health Management - covering all other environmental sanitation tasks;

3. Environmental Monitoring - by an Environmental Protection Division, in collaboration with the EPA; and

4. Planning, Monitoring and Public Relations - by the Health Department Head, or by a specialised unit of the Waste Management Department in Metropolitan Assemblies.

Waste Management Departments or Environmental Sanitation Divisions will have to ensure that adequate sites are available for the present and future storage, treatment and disposal of wastes. Up to 80% of the environmental sanitation services, however, will be provided by the private sector, including the voluntary sector, under public sector supervision. District Assembly Health Departments, supported by the EPA, will have to ensure that an Environmental Impact Assessment is produced for all activities likely to have a substantial impact on the environment, which they must monitor and enforce compliance with the impact statement. District Assemblies are also charged with the prevention of pollution, including monitoring all potential polluting activities, and actively collaborating with the polluters to resolve community-wide environmental problems. Significantly, their duties also involve the

protection of water resources, particularly those affected by inadequate waste management practices such as incorrect siting & operation of waste treatment/disposal facilities.

Traditionally, non-farming or taboo days had been used for managing the environment, under the leadership of the village chief. Unit committees are now expected to organise participatory neighbourhood cleaning once every two months. They are also expected to participate in planning and implementing projects, monitor environmental sanitation services at the neighbourhood level, and deal with uncooperative community members.

District Assemblies have to develop Strategic Environmental Sanitation Plans (SESP's), using a relatively short planning period of 10-15 years to stress that actions must be taken immediately, and each plan should be updated regularly. This SESP should identify facilities needed, recommend technical options based on user preferences and willingness to pay for each type of area to be served, set priorities, and outline the implementation and financing arrangements for each component, including private sector participation. The planning and design of programmes and services has to be based on the three planning principles of Sustainability; (which includes recurrent costs, complexity of operation, Spare parts and technical backup and Technical appropriateness), Cost recovery; and Technology choice. The SESP guides the implementation of selected components of the environmental sanitation programme, the 'Basic Programmes and Services', which are made mandatory and must be provided by District Assemblies to all communities without exception. These cover the collection and sanitary disposal of solid and liquid wastes; promotion of household toilets and phasing out of pan latrines, the provision of public toilets, cleansing of streets, drains, open spaces, and the provision/operation of cemeteries. They also include environmental sanitation education, the enforcement of sanitary regulations, the control of insect infestation, the inspection of foods and eating/drinking establishments, the inspection of premises and issuing certificate of habitation, and control of the rearing and straying of animals. Substantial capacity-building programmes will be required in the Kumasi City Region, since the district assemblies lack sufficient planning expertise to be able to implement the environmental sanitation policy. Further resources will also be required if the district assemblies are to engage in environmental monitoring as well as waste management and public health management.

Peri-urban areas appear to have the greatest needs for improved environmental sanitation, and so priority in the five districts of the Greater Kumasi City Region should be given to implementing the suggestions and provisions of the National policy on Environmental Sanitation. Solid waste collection activities would benefit greatly from adopting a regional approach since the disposal sites will serve several district assembly areas.

Treatment and re-cycling activities should be encouraged, both as part of a land restoration process, as well as providing economic inputs for agriculture. The involvement of the private commercial sector and the voluntary sector should be encouraged to participate in partnership with the district assemblies or regional agencies.

Other Environmental Priorities

Although discussed both by the planning consultants in the District Profile chapters of the current five-year district development plans covering Kumasi's peri-urban interface, as well as in various environmental studies, insufficient practical planning and actions in the Kumasi City Region have been given to other environmental considerations. These include (a) the implications of the loss of agricultural land, (b) the loss of fuelwood and timber resources, (c) the impact of sand winning and quarrying, (d) soil erosion undercutting houses, and (e) the disadvantages of increased levels of commuting.

Even though the area is undergoing transition, agriculture and other natural resources still currently provide a means of income or subsistence for many peri-urban residents, as well as employment opportunities. Without this production, food for Kumasi would have to be brought from greater distances, and the resultant increased transport costs would lead to higher food prices, reducing the sustainability of the city-region's economy. Good agricultural land, water and forest resources, etc., need to be identified and preserved as an integral component of any village development plans. Land use considerations need to be taken more fully into account in any village layout plans. Sufficient open spaces should be left within or around the village. Irrigable land along the valley bottoms might be protected and be set aside for growing vegetables or other higher value crops. Green belts, shelter belts or fire breaks do not appear to be planned, and so these might be encouraged around each of the village communities. Greater protection is needed against indiscriminate bush fires adopted as part of the slash-and-burn approach to agriculture in this area. The on-going loss of fuelwood and timber resources places a community at risk of increased soil erosion. If necessary, agro-forestry and afforestation schemes might be encouraged to counteract land degradation, with private commercial and voluntary sector participation in the provision of tree nurseries.

Existing policies of issuing permits for sand winning and checking illegal activities might be reinforced by considering wider land use implications within each district, which can then be extended to the entire Kumasi city region. Former sand winning sites or quarries could be investigated to assess their suitability as waste disposal or landfill sites as part of a

land restoration programme. Since many of these sites are close to streams, this requires the development of management procedures to provide adequate protection of the water table. Proliferation of too many small extraction sites has created problems in controlling activities and in the phasing of exploitation. Appraisals of all current and proposed sand winning sites would help identify those creating the greatest nuisances for nearby residents and neighbouring communities, particularly on the safety aspects of truck movements through settlements, the damage to roads being used, and the general dust/noise created. With the assistance of the Environmental Protection Agency, regional, plans for the entire city region might be drawn up and agreed with the registered contractors' associations. Initial priority might be given towards first utilising those sites closest to the urban areas which provide the markets for the sand, before moving on, in a phased manner, to more distant sites.

In the past little attention has been given to providing adequate street drainage. Soil erosion, which undercuts house foundations within villages, also stems from past inadequate attention given to identifying the most appropriate alignment of houses in relation to flows of water. Increased runoff due to the increase in urban construction in the peri-urban areas is likely to increase this problem. Planners and engineers will need to ensure that this problem is tackled through appropriate drainage schemes along the roads, and the application of improved urban/village design principles, including retaining sufficient space around each house.

Haphazard urban developments in Kumasi's peri-urban areas may already have resulted in the weakening of existing traditional social and cultural structures. Future tensions may be expected between indigenous villagers and more affluent 'strangers' in new houses with high levels of domestic facilities, but with possible expectations of urban levels of infrastructure. These may be trading off more travel costs to reach their workplaces in Kumasi for more space in new houses built in attractive environments. Cheaper housing or rented accommodation within the peri-urban villages may contain rural-urban migrants, unable to afford more expensive housing within the city itself. Indigenous family members, unable or unwilling to engage in farming, have been found to seek non-farm employment in Kumasi in petty trading or hawking activities if they lack skills, or in the informal sector, especially if they are able to gain an apprenticeship. Already, substantial numbers have been found to be travelling daily from peri-urban villages to work in Kumasi. Some travel frequently to Kumasi to sell produce, although most undertake these journeys to acquire produce or goods to sell within their villages. Whatever the reason for these journeys, the increased travel to Kumasi has already resulted in growing traffic congestion at specific bottlenecks within the city which has visibly increased over the past three years. This situation is likely to get worse as more passengers and vehicles travel from the peri-urban areas into the central areas of Kumasi.

Environmental Planning and Management Approach

A public-private partnership is needed if these planning and environmental problems are to be solved. Limited public sector revenue sources within the district or Common Fund resources allocated by central government for the district assemblies means that they will need to involve the private commercial or voluntary sectors to achieve environmental improvements. Initial preparatory work should identify environmental problems through the preparation and discussion of district environmental profiles, leading on to village or urban neighbourhood environmental profiles. These would then be brought together for the Kumasi City Region. Further considerations by working groups on priorities should lead to the identification of groups willing and able to take responsibility for implementing specific components of the environmental plan. This action planning should help ensure that priority environmental problems are being tackled in a cost-efficient manner in accordance with the community's wishes without imposing substantial project costs on the district assemblies or other public sector agencies. This approach has been adopted by the Urban Management Programme of the World Bank/UNDP/UNCHS(Habitat), and has been utilised by many of the multilateral programmes, such as Habitat's Sustainable Cities Programme. Many of the initiatives developed to meet Local Agenda 21 requirements have adopted a similar approach. Once local communities within the Kumasi City Region become actively involved in identifying environmental problems and their priorities for dealing with them, they are likely to become more actively involved in initiatives and partnerships to deal with them. A higher profile is likely to emerge from the grassroots in urban and peri-urban areas for tackling local environmental problems.

Geographical Information Systems for the management of natural resources in a peri-urban environment – KUMINFO

Introduction

A GIS has been developed during the course of the project, based on a pre project prototype developed by GDS (Geographic Data Support) Ltd. called the **P**eri-**U**rban **D**emonstrator for **S**patial Data **I**ntegration (PUDSI) system. As the project matured and the requirements of the researchers were defined, PUDSI has been enhanced and developed to the present system, known as Kuminfo v2 (**Kum**asi **Info**rmation system, version 2). The GIS is based on commercially available software (Arcview, Spatial Analyst and the Access database) and runs in either the Windows95 or NT4 operating systems and is run in Kumasi by a GIS co-ordinator and a data manager with parallel systems in the UK.

The Kuminfo GIS

The Kuminfo GIS has been tailored to meet the needs of researchers working on the Kumasi Natural Resources Management Research Project. Extraneous GIS functions are not accessible to the user. The data are viewed and analysed through a series of graphical user interfaces (GUI's). These GUI's are designed to deal with either general data or project specific data. Some of the larger research topics have their own interface, whilst others are accessed through the general interfaces (Table 64, figures 32-34).

Table 64. Kuminfo Interfaces, data and GIS capabilities

Graphical User interface	Projection	Datasets	GIS Functions specific to interface
Ghana general	Geographic	Country boundary Old district boundaries New district boundaries Mean monthly temperature Mean annual temperature Mean monthly maximum temperature Mean monthly rainfall Annual rainfall Potential evapotranspiration Topography (1:3mill) Forests Estimated population Whites vegetation map	none
Ghana UTM	GNG*	Topography(1:3mill) National Parks Old district boundaries New district boundaries	none

Kumasi general (Fig a)	Geographic	Topography (1:1m, 1:50,000) New district boundaries Ashanti forest reserves ADP** demonstration data Isolines from Kumasi Ashanti protected areas Soils (Fig e)	graphs Select points relative to another theme Export tabular data Import text files Zoom to ADP demo Clear graphics
Kumasi UTM (Fig b)	GNG*	Topography (1:50,000) Ashanti old districts Ashanti new districts Soils Kumasi 1:10,000 (water data) Isolines from Kumasi ADP** Index Kumasi city waste dumps Kumasi city definition 1968,1992 Kumasi submetropolitan areas and zones Sandwinning sites Spot Image 1994 Soils with text Agriculture in Urban Gaps Change in village area 1984 - 1994 Urban agriculture (Fig f) Trotro survey	graphs Select points relative to another theme Export tabular data Import text files Clear graphics
District level planning	GNG*	Topography (1:50,000) Village sites District Questionnaire results	graphs Select points relative to another theme Export tabular data Import text files Clear graphics Buffer features Bespoke legends District selection Output maps to scale
Participatory rural appraisal	Geographic	Topography (1:50,000) PRA settlements & reports	Graphs Select points relative to another theme
Urban Footprint	Geographic	Topography (1:1m, 1:50,000) Commuting zones Urban Footprint	Export tabular data Import text files Clear graphics

VCS (Fig c)	Geographic	Topography (1:1m, 1:50,000) Isolines from Kumasi VCS questionnaire results VCS cluster analysis	Graphs Select points relative to another theme Export tabular data Import text files Clear graphics Bespoke legends
Village level mapping	GNG*	Topography (1:50,000) GPS walk points Mapping villages Aburaso land use planning Swedru land use planning	Graphs Select points relative to another theme Export tabular data Import text files Clear graphics
Watershed management	GNG*	Topography (1:50,000) School water sampling Study villages Water sampling site Stream numbers analysis Main watershed Digital elevation model	Under construction

*GNG Ghana National Grid; **ADP Aerial Digital Photography

Fig 32. The Kumasi general geographic interface illustrating soils of the Kumasi region and a report retrieved from within Kuminfo

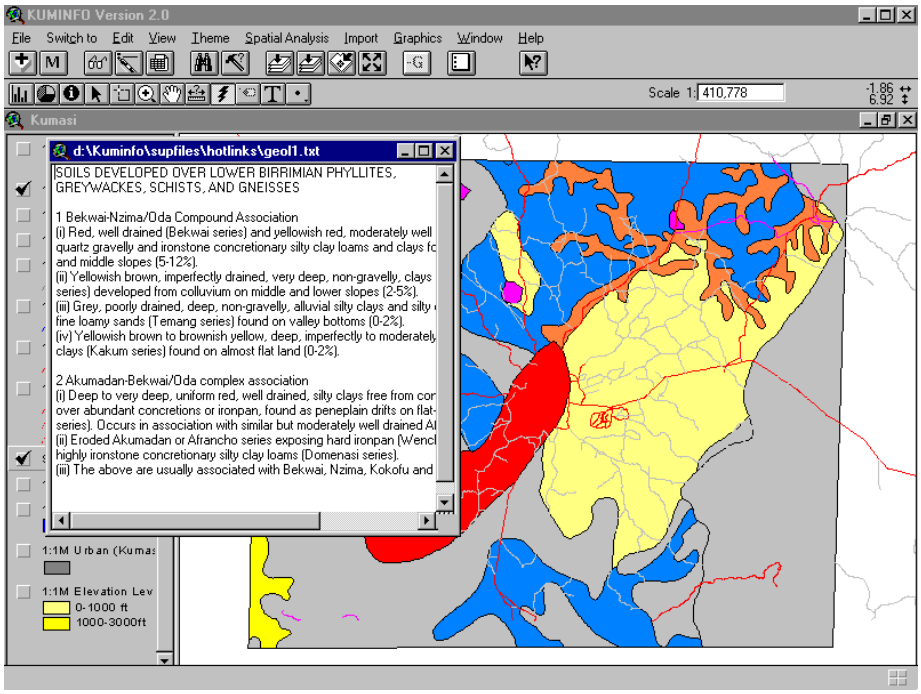


Fig 33. The Kumasi UTM Interface (Ghana National Grid) showing results of a study into urban agriculture

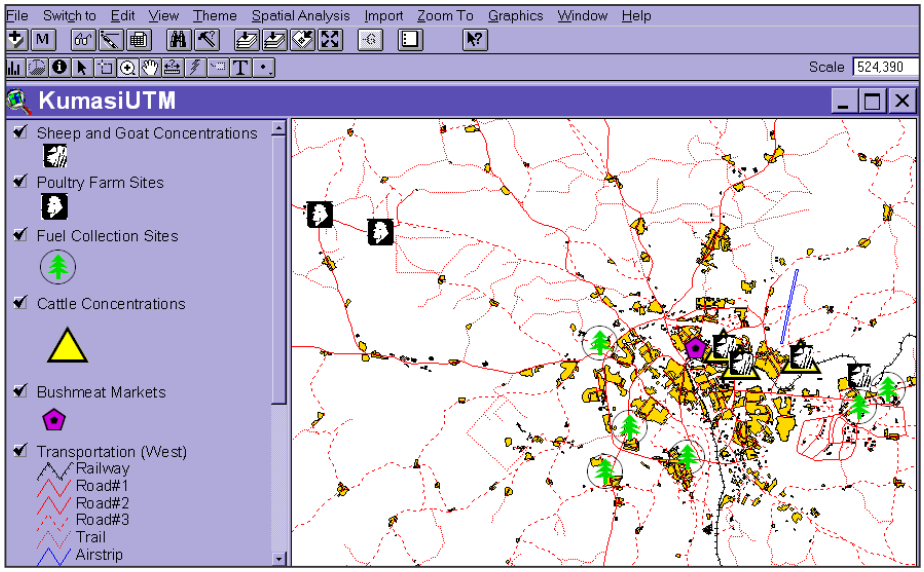
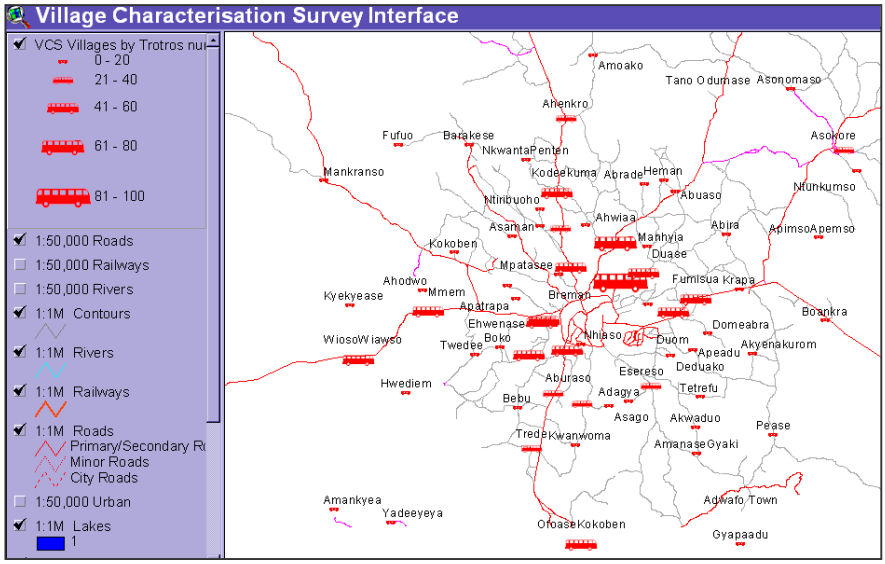


Fig 34. The Village Characterisation Interface showing the number of trotros leaving for Kumasi daily from 66 survey villages.



Within each interface the user is provided with a set of tools to query, analyse and classify the datasets as well as menu items to enable the user to move easily from one part of the system to another. For example every interface has a button marked M (Figs 32 & 33). When activated this button shows a table of all the data that can be added to the current view and the user is invited to choose items from the table. All interfaces have tools that allow

selection by boolean or mathematical operators and tools to enable datasets to be queried in relation to each other (for example selecting all villages that fall within a certain altitude range). Tools are also available to add tabular data to spatial data by means of a common reference field (for example village name or field code) as well as adding related text data by means of a 'hotlink'.

Data can be output as hard copy maps, tables and reports or saved digitally for inclusion in documents or exporting to other software packages.

When leaving the Kuminfo system, all added datasets and analysis are deleted. However, there is an option within the system to allow the user to save their work so that it is not lost.

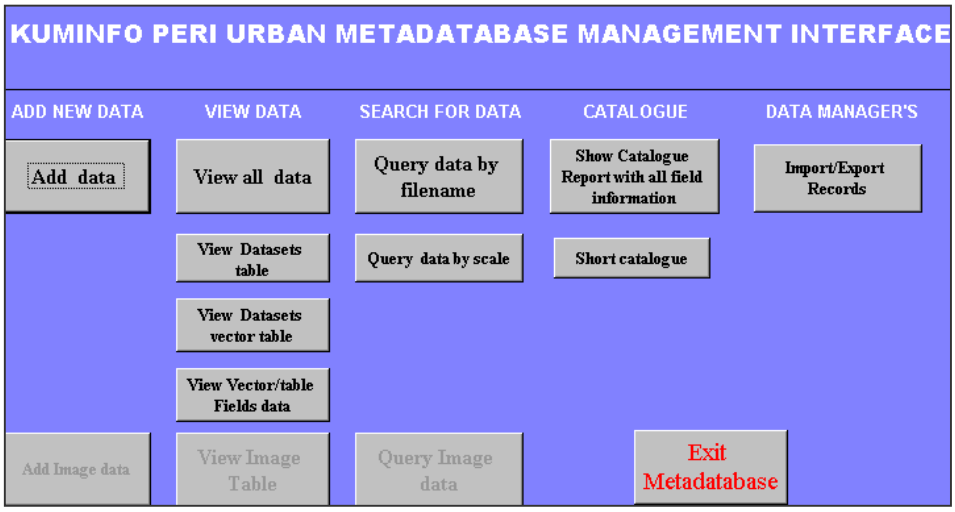
The Kuminfo Meta-Database

A meta-database for handling all data within the Kuminfo GIS has been created using Access software. The meta- database functions as a management tool for all the spatially related data in the system and it facilitates the following tasks

1. Access to coverages of the same projection and similar scales from within the Kuminfo GIS
2. Management of information by the data manager
3. Easy transfer of data between sites where Kuminfo is installed
4. The production of user catalogues.

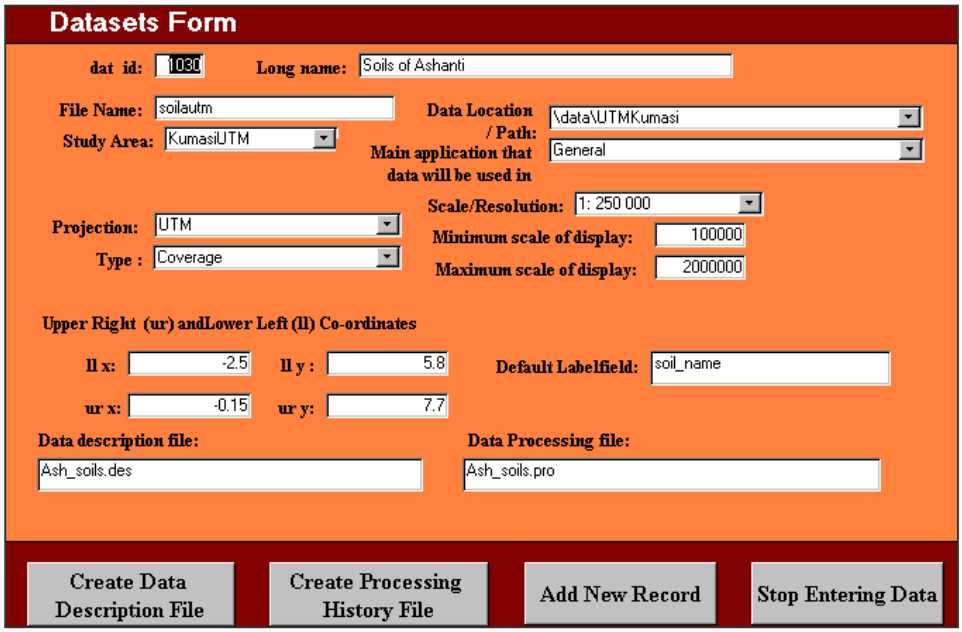
These functions are accessed through an entry menu screen (Fig 35)

Fig 35: Management tools in the Kuminfo meta database



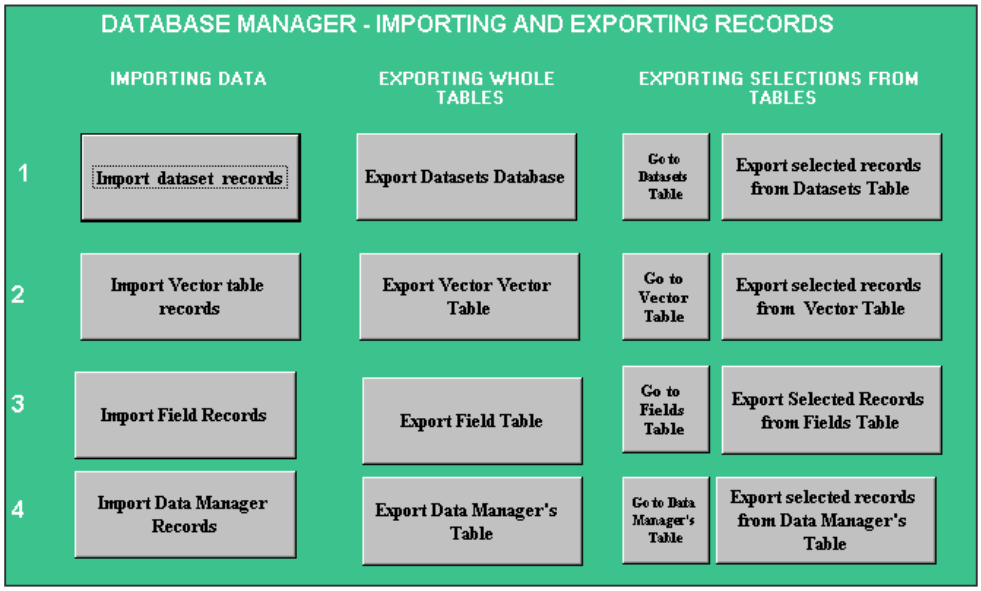
The 'Add data' button on the entry menu screen (Fig 35) allows access to a second form which guides the data managers to manage the database and the catalogue. Fig 36 shows a portion of this form.

Fig 36: The form for managing spatial data in the Kuminfo meta database



A system of protocols has been developed for exchanging data between systems in different locations. Each site is designated a list of unique numbers which are related to elements in the database (record numbers, attribute field numbers etc). To exchange this information between sites, an import/export form guides data managers through a series of macros to extract the necessary information from the data base (Fig 37).

Fig 37: Importing and exporting data between sites



The Kuminfo Data Catalogue

The main screen of the meta database also allows access to a catalogue of all the data present in the system (Fig 35). The long catalogue informs the user of all the information available about a particular dataset (Fig 38), while a shorter catalogue tabulates key information.

Aerial Digital Photography (ADP)

The project R6880 'Development of Methods of Peri-Urban Natural Resource Information Collection, Storage, Access and Management' acquired 1416 aerial digital images (ADP) in December 1997. An image index in Kuminfo identifies relevant images and their position on one of the 22 CD-ROMs of raw data. The images have a nominal spatial resolution of 25cm and are extremely useful for detailed mapping. Images have been have been extracted from the archive and geo-corrected for use with other GIS coverages in several of the research projects (Table 65).

Fig 38: Long catalogue sheet

Table 65: The use of aerial digital imagery in research topics

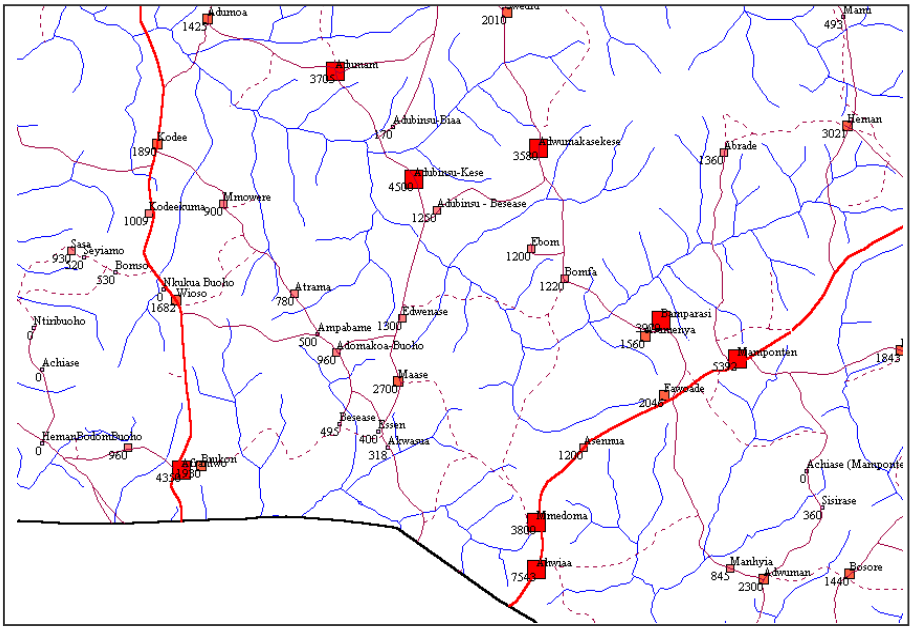
Research Topic	Use of ADP Imagery
Agriculture in Urban Gaps	To delimit cropped area and identify some crops
Village level planning	Identify and map village boundaries
	Identify land use patterns
	Distinguish between traditional houses and newer villa developments
Watershed villages	Land use patterns
	Detailed identification of features surrounding sampling points

.

District Level Planning

As part of the district planning component of the project, a questionnaire encompassing every village in four districts (Atwima, Bosomtwi – Atwima- Kwanoma, Ejisu Juaben, and Kwabre) has been completed. In order to make these data available in map form to the planners, tailored GIS projects have been provided with for each district. These projects are based on the freely available Arcexplorer software. This enables simple queries and classification of the data and output in map form (Fig 39).

Fig 39. 1998 Population of the southern part of Kwabre District as displayed in Arcexplorer



If more sophisticated GIS analysis of the data is required (e.g. buffering or combining data from more than one dataset) the planners are encouraged to use the full Kuminfo system at the Institute of Renewable Natural Resources (IRNR) at UST. The full planning GUI has

extensive spatial tools, tailored representation of up to 40 analyses and a facility to print out to scale.

Other databases

Questionnaire data collected during the prosecution of the research projects has been entered in various Access databases and are stored within the Kuminfo structure. These are shown in Table 66.

Table 66: Ancillary Access databases stored in Kuminfo

Database	Research Topic
vcsinput	Village Characterisation Survey
trotro	Results of a trotro survey
urbgaps	Agriculture in Kumasi urban gaps
planning	District Level Village Survey
wvcs	Watersheds village characterisation survey

Printed manuals

A KUMINFO User's Manual, Metadatabase Catalogue and Data Manager's Manual are in advanced stages of preparation.

CONTRIBUTION OF OUTPUTS

Promotion pathways for the present research

The goal of the research programme, which is ultimately also a developmental goal, is that the livelihoods of poor people should be improved through sustainably enhanced production and productivity of renewable natural resource systems. Being a systems project, the dissemination pathways must inevitably be numerous and traverse different parts of the livelihood and production systems, and yet be designed to reach the same ultimate goal. As implied in the earlier background section of this report, it is the government and traditional authorities who should be the most important recipients of the project findings, so as to establish policies and programmes that will best cope with the inevitable trend of urbanisation without displacing resources away from the poor, or potentially poor.

It is therefore essential that the project brings its findings both to the decision-takers who have specific responsibilities within the Kumasi peri-urban area and to the wider audience in the developing world. How this has been or will be done is now described, taking the envisaged and actual project outputs and enunciating the promotion pathways firstly within the Kumasi peri-urban area and secondly in the wider development context.

General material

An audio-visual presentation of the work of the project in general has been produced and made available on compact disc to DFID and interested researchers. The BBC World service recently interviewed project staff for their "In the Field" programme.

A joint paper with the Hubli-Dharwad PUI project team, which reviewed the findings of both projects, was provided to DFID in 1998 but not published.

Land management and livelihood systems

The socio-economic studies into land issues culminated in the presentation by Professor Kasanga at the final project workshop, which was attended by representatives of key authorities, the national press and media. The land management framework proposed includes participatory land use planning and has been piloted in two peri-urban villages. The next stage on this promotion pathway has been discussed with the Asantehene and a forum of the traditional authorities, most probably on a national level, is to be convened in April 2000. Strategies for improving livelihoods opportunities for the peri-urban poor are summarised in the "Coping with Urbanisation" report by Ms Warburton, which will be given a wide circulation in Ghana. Further dissemination outputs will include a journal article and a request for ASS funding may be made to produce more generic reports (this applies to other project

areas as well).

Sustainable agricultural productivity

The project has concentrated on soil fertility issues and already followed a pathway leading from the research findings on poultry manure and composting of waste products to extension agencies (MoFA and GOAN) and thence to a wider audience of peri-urban farmers. The development work in which they have engaged as part of the project has provided materials which can be used in subsequent campaigns and in other locations. Local radio stations have been used for promoting the project findings in this work area. Opportunities for disseminating findings at international workshops have already been taken and will continue to be sought.

Urban natural resources

Again, the principal dissemination pathway has to date been through the final project workshop and the urban gaps study report will be given wide circulation in Ghana and internationally.

Planning

The series of workshops which has been held with the planning staff of the peri-urban districts of Kumasi has formed the principal promotion pathway for the project findings on district planning and information needs, and has stimulated the provision of information by the planners themselves which has allowed the construction of a working GIS which has potential for application in Kumasi and providing as an example in other peri-urban areas internationally. The prospective publication of an article in a respected planning journal will bring the findings to a wider audience.

GIS

The KUMINFO system has been described and demonstrated at several international research workshops and continues to be used for research purposes in Kumasi and NRI, in addition to the use of the planning interface described above.

Requirements for further research and development projects

These were reviewed in the final project workshop. Promising areas for further research suggested are listed in the following table. The Peri-Urban Knowledge Consolidation project (R7549) will be reporting at the same date as this project on its findings and with suggestions for further funding by DFID into peri-urban research (and possible development project topics).

Table 67 :Results of final workshop discussions on future R&D projects

	TECHNICAL	INSTITUTIONAL	POLICY
RESEARCH	• Definition and gender dimensions of poverty in the peri-urban / rural areas of Kumasi • Linkages between participative and conventional planning • Appropriate compensation to land users • All aspects of pollution – its extent, causes, routes, impact and appropriate technologies for disposal / alleviation • Continuation of work on organic soil ameliorants (rates, handling, analysis, cover crops / green manuring, mulch management) • Characterisation of soils within peri-urban areas	• Integration of participative whole-village planning incorporating natural resource and environmental considerations into conventional planning processes • Institutional framework for implementation of environmental policies • Characterisation of the accessibility of and constraints on peri-urban farm input supply	• Setting aside of special areas for urban / peri-urban agriculture • The principle of "Polluter pays" • A development tax on housing

DEVELOPMENT	• Water quality monitoring system • Appropriate technology for cleaning up pollution • Developing technical information kits through training which can then be used for sustained agricultural extension work. Subjects to include integrated pest and nutrient management and the safe use of agrochemicals • Training peri-urban farmers in agro-processing & high-value enterprises • ADP coverage to be extended to all peri-urban areas	• Supporting institutional mechanisms to channel the process of participative planning • Training, staffing and equipment for EPA, Water Resources Commission, Ghana Water Company • Development of processes for strategic planning • Strengthening of district environmental committees, with links to communities • Strengthening traditional authorities to play a positive role in land use policy, planning and management • Incorporation of GIS into district planning process (i.e. capacity building in GIS at the regional / district level)	• Making citizens aware of their rights & supporting institutional mechanisms to this end • Encouragement of transparency in planning processes • Conducting EIA's and creating public awareness of the findings • The use of farmer field schools in extension • Dissemination of the results of this workshop to the Traditional Council

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Other dissemination activities

- Professor Kasanga mounted a stand on the project at the Shanghai World Environment Forum October 1997.

- Materials for a presentation by Dr. M. Gill, Head of NRInternational, for the Commonwealth Heads of Governments Conference in 1997 were supplied and a short presentation made. Interest was noted in particular from the Commonwealth Human Ecology Council.

- The KUMINFO GIS was demonstrated to a meeting on land use and livestock at FAO in December 1997.

- Professor Kasanga and UK lead research team members made presentations and participated in discussions at the brainstorming workshop held jointly with the Hubli-Darwad researchers at DFID on 10th. December 1997.

- An information sheet (in English) for distribution to the academic and development community in Ghana was been produced and some 200 copies distributed. The purpose was to keep these people abreast of project activities and findings.

- The UK lead research team members attended an "Urban Exchange Day" at Imperial College, London in January 1998.

- A joint contribution with the Hubli-Dharwad project to a DFID Research Advances paper was submitted in 1998.

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ADDENDUM TO R6799 FINAL TECHNICAL REPORT

This addendum is provided in response to the request of the NRSP Programme Manager (letter of 15 August 2000 Dr FM Quin to Mr M Adam refers).

Part 1 : Achievement of outputs and activities

The **research outputs** as summarised in the Project Completion Summary Sheet and the Executive Summary of the FTR correspond to the detailed logical framework outputs and activities as follows:

Table 1. Correspondence of overall project outputs to logframe outputs and activities.

Summarised Research Outputs from PCSS and FTR	**Details of phase 2 logframe outputs and activities from RD1 (Table 2).**
Framework for improving land management and livelihood systems, particularly for low-income peri-urban inhabitants	"Strategies for improving land management & livelihood systems"
Frameworks for analysis, leading to understanding, of agricultural and natural resource utilisation (including urban Kumasi)	Largely carried out in the inception phase, plus "Soil fertility" and "Urban natural resources"
Strategies for sustainable agricultural productivity	"Soil fertility" and "Urban natural resources"
Framework for analysis of planning constraints and information needs	"Improved information for NR planning"
Strategies for improved planning processes, focusing on natural resource and environmental issues	"Strategies for improving land management & livelihood systems" (outputs 1.4 and 1.5), and "Improved information for NR planning" (output 4.1)
Information systems to aid research and planning	"Improved information for NR planning"

Table 2 on the following pages provides an assessment of the level of attainment of the detailed project outputs and activities.

Table 2. Achievement of outputs and activities. Assessment based on logical framework for consolidated and revised phase 2 of project.

PLANNED OUTPUTS	ASSOCIATED ACTIVITIES	CHANGES	ASSESSMENT OF LEVEL OF ATTAINMENT
Project Management			
Research projects continue smoothly. Results of research disseminated to stakeholders.	Each lead research team member to visit Kumasi at least twice per year to establish and manage research programme. Maintain regular contact with Kumasi researchers and British Council to ensure professional and financial targets are met. Supervise production and distribution of information and publicity materials.		Output attained: visit schedule fully achieved; financial management of local funds by British Council satisfactory. Local dissemination (print, broadcast) most successful when assigned to non-academic NGO. When left to academics, generally not very successful.
Strategies for improving land management & livelihood systems			
1.1 Review project research and findings on land use and tenure and refine methodologies and frameworks for analysis of land tenure issues, taking into consideration legal and policy aspects of land tenure.	1.1 Commission consultancy to review project research and findings on land use and tenure, provide relevant examples from other areas, provide advice on legal and policy aspects, guide future project analyses and activities and advise on dissemination of findings on land tenure issues.	This activity was introduced by PSL in mid-1998.	Not attained. It proved impossible to maintain contact and commitment from the preferred consultant.
1.2 Analysis & dissemination, through published reports of information on peri-urban land allocation and management systems.	2.1 Synthesise information from the specialist studies on land tenure into a document which can be used as a resource accessible to Ghanaian and non-Ghanaian researchers and policy-makers 2.2 Carry out a comprehensive analysis of data collected from the village characterisation survey (VCS) and present the findings both as a resource document for other researchers and as a publication in a refereed journal.		Activity 1 not completed before end of project, although one synthesis was contained in the FTR (pp 67-86), and papers including data from the project were produced. (Kasanga 1999) The project researchers have covered land tenure issues in considerable detail. Activity 2 partially covered in the relevant sections of the FTR (pp 67 - 157). Publication in *The Land* (1998) partially covers journal requirement. Note that the VCS was carried out in the inception phase.

1.3 Impact of changes in control and access to resources due to urban growth on the livelihoods of peri-urban inhabitants and the social structures within local communities identified.	3.1 Carry out a structured questionnaire survey of households and individuals in selected villages to ascertain the major occupations, access to farmland, housing 3.2 Conduct a wealth ranking exercise within the 3 villages (men and women) 3.3 Carry out case studies of indigenous and non-indigenous families and individuals. This would include tracing studies of displaced farmers and relationships between the individual and local community. Family histories would be used to trace changes in livelihoods through time. Topics would include entitlements to natural resources, sources of income, food self-sufficiency, social networks, links to Kumasi 3.4 Survey target groups (subsistence farmers, underemployed casual labourers), their sources of income and access to resources, including capital, credit, labour, training. 3.5 In case study villages, undertake a survey of all homeless and landless people in the village, their means of support, links with village communities, access to resources. 3.6 Disseminate survey results back to villagers	These outputs and activities are all the product of a review at the end of the inception phase in late 1997.	Activities 1,2, and 5 were carried out and resulted in the production of individual reports in 1999 on wealth ranking, family case studies, community-based groups, and homelessness. (These have not been combined as a formal NRI report). These are summarised in the FTR, between pp. 67 – 132. There were insufficient resources to trace back and interview displaced farmers who had left the location, so information about them was collected from family members who remained in the village. For activity 4, no specific studies were done on subsistence farmers and labourers, as information on these groups was already contained within the Household survey and family case studies. Lack of time and resources did not allow for further in-depth case studies. The proposed tracing studies and target group surveys (activities 3 and 4) were not carried out due to lack of time and resources. Their inclusion was perhaps over-ambitious. The results of the research were conveyed to and discussed with village representatives at project workshops, especially that of February 1999. Findings were presented fully at the February 2000 workshop and FTR pages 67-157.
1.4 Analysis of structures and operations of existing community-based groups and the linkages with higher levels of government, NGOs and other groups. Recommendations on their potential for implementing sustainable policies and disseminating information.	4.1 In case study villages, undertake a study of all community-based groups (including Town Development Committees) to determine the composition, roles and effectiveness, together with power relationships within existing groups. 4.2 Analyse the linkages between villagers and outside institutions concerned with natural resources, in particular, district planners, extension staff, NGOs, and the available sources of information. 4.3 Recommend ways in which community groups can increase their effectiveness and incorporate environmental issues into their agenda.		These activities were largely attained and reported on in the report of the aforementioned community groups study, and also the NRI "Report on the District Assembly Committees : the Environmental and Unit Committees within the Peri Urban Areas of Kumasi", March 2000. Recommendations on community involvement are given in this latter report and the FTR page 216.

1.5 Strategies to make land use management more efficient, equitable, environmentally sustainable and more accountable developed in selected villages	5.1 Using information from (2) and (3), prioritise issues in village land use management with key stakeholders/community groups in the village, noting differences in priorities and any conflicts of interest between groups. 5.2 Working with community-based groups, identify any information needs and options for land use management 5.3 Develop pilot strategies for improvements in land use management in selected villages (utilising information from KUMINFO and other sources as required).	These are some of the "substantive" or "solid" outputs required by programme management at the 1998 logframe revision.	Output attained : the participatory land use planning (PLUP) exercise was carried out in two villages and was reported in the FTR at pp. 141-157.
1.6 Strategies to increase incomes appropriate for low-income peri-urban inhabitants, particularly displaced farmers, landless and homeless developed in selected villages.	6.1 Identify current examples of successful income-generating activities in peri-urban areas (using information from (2) and (3) and key informant interviews). 6.2 Identify unsuccessful income-generating activities and the associated causes. 6.3 Identify resources available within the peri-urban area 6.4 Identify options for income generation and assess the practical viability of each option including: • demand for the product or service • resources required to produce it • training, organisational and management requirements • long-term sustainability 6.5. Undertake participatory pilot projects in selected villages.	This section was given a greater poverty focus in the revised and consolidated logframe of 1998 as part of the review of phase 1.	Output partially attained : the field work has provided a mass of data which was addressed in the FTR pp 132-140 under "coping with urbanisation". It had been intended to produce a more comprehensive report with the same title, but this has not been possible due to running out of time. Additional NRI report by the project planning experts, "Dealing with poverty issues etc." (March 2000) refers. In hindsight it was over-ambitious to set out the activities under 6.4. and 6.5: at the time of logframe revision there was NRSP management pressure to do so; it is apparent from subsequent programme logframe revision that these activities constitute the essence of the later stages of the programme, destined for attention in 2001-2004 and not before.
1.7 Workshops conducted on land use management & income-generating activities in the peri-urban area with local inhabitants and policy-makers and researchers	7.1 Conduct workshop on land use management and income-generating activities to local inhabitants and decision-makers. 7.2 Conduct workshop to present findings from the land use management and income-generating activities to policy-makers & researchers and develop dissemination and training pathways.		This output was attained through community consultation and development of land use management plans, especially in the PLUP exercise referred to under 1.5, and also through a number of workshops.. However, more progress was achieved in the development of land use issues than in developing income-generating activities. Workshops for the local communities and for researchers and local stakeholders held in 1999 included the presentation of project findings and discussions on the issues raised. The final project workshop in 2000 and the Community Workshop for the Traditional Authorities provided further opportunities to present and discuss findings to the wider audience specified in the activities here.

Soil fertility			
2.1 Review of peri-urban waste streams products for soil amelioration in the Kumasi peri-urban area.	1.1 Commission a consultancy on peri-urban waste stream products for soil amelioration in order to a) provide an overview of the use of waste stream products in the peri-urban situation and b) review findings of the field work to be carried out under activities 2 and 3 below.	Introduced for phase 2 logframe 1998 at suggestion of PSL.	Attained. Professor P. Harris, HDRA, commissioned and prepared report on "Peri-urban waste stream products for soil amelioration", April 1998.
2.2 An inventory of available resources with the potential to improve soil fertility within the Greater Kumasi City Region.	2.1 Interview key informants, access secondary data on the availability of organic and inorganic resources with the potential to improve soil fertility. 2.2 Derive estimates of the quantities of nutrients available. 2.3 Compile an inventory of soil fertility improvement resources for the GKCR.		Attained. Reported on in NRI report "Supply and demand for soil ameliorants in peri-urban Kumasi", July 1999.
2.3 A review of the present and potential future use of these resources in the Kumasi peri-urban area, taking account of economic and socio-cultural factors and a range of potential uses.	3.1 Interview key informants, access data and estimate present use of the resources inventoried. 3.2 Collect data on potential future use of and demand for these resources. 3.3 Report on present and potential uses of locally available soil fertility improvement products.		Attained. Reported on in NRI report "Supply and demand for soil ameliorants in peri-urban Kumasi", July 1999.
2.4 Determination of farm-level nutrient flows in vegetable production systems, comparing the use of inorganic, organic and INM techniques.	4.1 Identify organic manures, including cover crops, suitable for analysis and field trials. 4.2 Conduct chemical analyses of available organic manures. 4.3 Select suitable vegetable farmers in peri-urban Kumasi with whom to participate in a two-year programme of experimentation on INM for vegetable production. 4.4 Identify suitable collaborating organisations at the village and/or district level. 4.5 Establish parallel researcher-managed trials at the Crops Research Institute in Kumasi. 4.6 Set up trials, conduct soil and crop analyses and record inputs and outputs. 4.7 Participatory monitoring and evaluation exercises at regular intervals. 4.8 Report on the trial treatments in terms of nutrient balances and the five pillars of sustainability (FESLM 1991).	Detail of outputs and activities introduced for phase 2 logframe 1998 as part of the review process following the inception phase.	Largely attained, with provisos. Trials carried out on nutrient applications and Mucuna in farmers' fields & at UST horticulture station for the former (replaced CRI). Collaborated with Ministry of Agriculture Extension service. Reported on in NRI reports on "Poultry manure trials", "The management of fallow, using Mucuna, for subsequent tomato production", "Nutrient balance studies" and "Poultry manure facilitation exercise" (all March 2000). The trials all had very low yields, thus precluding the generation of substantiated recommendations. However, recommendations for the use of poultry manure derived from earlier work, and as used in the trials, were brought to the extension service and promoted. A full report as proposed in activity 4.8 was not produced, for the reason of low yields invalidating results.
2.5 In conjunction with the CPP Composts to Control Pathogens project, an assessment of appropriate-scale composts production for peri-urban farming systems.	5.1 Conduct farmer-level appraisals of the feasibility and acceptability of appropriate-scale compost production and provide cost-benefit analyses. 5.2 Set up trial-demonstrations of composting at villages with which the project has contact.	Detail of outputs and activities introduced for phase 2 logframe 1998.	Attained. Earlier PRA work had dealt with 5.1 and, in collaboration with the Ghana Organic Agriculture Network (GOAN), the use of compost was promoted and disseminated in a peri-urban village. NRI report "Composting promotion, etc.", March 2000 refers.
2.6 Recommendations, including decision trees, to aid adoption of appropriate INM practices by peri-urban farmers.	6.1 Develop dissemination outputs. 6.2 Derive from and provide information to the KUMINFO GIS.		Partially attained. Extension printed materials were developed for and with the Ministry of Agriculture and GOAN and broadcasts on local radio facilitated by GOAN. The reports are yet to be incorporated into the GIS. Decision trees not developed due to lack of basis for recommendations.

Urban natural resources			
3.1 Definition and description of the extent and types of natural resource production systems within the Kumasi Metropolitan area.	1.1 Examine and demarcate urban natural resource production areas. 1.2 Detailed evaluation of agricultural activity using ADP. 1.3 Ground-truthing exercises.	Whole of this output and activities section introduced at phase 2 logframe 1998, primarily at the suggestion of the NRI agriculturalist.	Attained. Students and supervisors commissioned to carry out general urban NR studies (NRI report "Kumasi Urban NR studies" June 1999 refers). More detailed study of urban agriculture, using ADP material, also commissioned from student and supervisor and reported as NRI "Report on study of urban agriculture in the urban gaps of Kumasi city", March 2000.
3.2 Assessment of the socio-economic characteristics of urban farmers	2.1 Review of material collected in the on-going livelihoods survey. 2.2 Key informant interviews and surveys of a selected community or communities within the KMA. 2.3 Assessment of socio-economic characteristics of urban farmers		Attained but only as an analysis of the material collected in the student studies rather than incorporating material from livelihoods studies (Outputs under Strategies for improving land management & livelihood systems).
3.3 Description and explanation of inputs and outputs peculiar to the system by virtue of its urban location.	3.1 Workshop to develop proposals for further research. 3.2 Incorporation of findings into the KUMINFO GIS.		Attained. Discussed at both 1999 and 2000 workshops. GIS interface created.
3.4 Proposals for improving the productivity of the systems.	4.1 Set up and conduct further research and development work identified following the workshop.		Partially attained. Recommendations made in the reports but not given full attention to follow-up with relevant authorities.
3.5 Further research and development of these proposals.			Not attained. May form part of the work in later stages of the programme as a whole.

Improved information for NR planning			
4.1 Analysis of information requirements for improved natural resource management and planning at the regional, district and village levels	1.1 Undertake a study with key stakeholders at regional, district and village levels involved in planning to identify their data requirements and analyse how the data would be used to improve natural resource planning and incorporate environmental concerns. 1.2 Draw up outline of user requirements for data and system design 1.3 Identify feasibility of supplying data through the GIS system (in terms of availability and maintenance)	These outputs and activities reflect an increased emphasis on GIS and reduced detail on planning processes as put forward by programme management following the review of phase 1.	Attained and in a sense exceeded. The dialogue with the district planners initiated by the project development planner in the inception phase continued and resulted in the production of material to aid understanding of and develop strategies for the planning processes. These were reported under NRI reports on "District Development Planning Methodology" (April 2000), and "District Assembly Committees" (March 2000). At the series of meetings with the planners, information systems with reference to GIS were discussed.
4.2 Incorporation of available, required information into the KUMINFO system	2.1 Incorporate required (where possible in the scope of the project) and available data into KUMINFO 2.2 Design and develop user-interface		Largely attained. Material from the inception phase (PRA, VCS) and later phases (urban agriculture, planning and commuter transport [trotro] data) was incorporated into the GIS. Additional data on commuting was collected and reported in NRI report on "Trotros passengers and commuters etc." (June 2000). This report also highlights environmental concerns.
4.3 Development of a pilot system for use by natural resource planners for selected communities	3.1 Develop a pilot system for selected users in case study communities and districts		Attained. Pilot system made available to one of the districts and the interface subsequently extended to all peri-urban districts.
4.4 KUMINFO GIS continues to provide facilities for researchers to store and analyse results of trials and surveys.	4.1 Continue to make the storage and analytic facilities of KUMINFO accessible to researchers		Attained. KUMINFO also made available to other NRSP projects such as R7330 Kumasi Watersheds. "KUMINFO User Manual" produced (July 2000).
4.5 KUMINFO GIS is adapted and improved in response to requirements.	5.1 Adapt, improve and take measures to ensure the sustainability of the KUMINFO GIS		Attained. KUMINFO continues under the same management, in the Watersheds project.
4.6 Assessment of the use of the GIS as a planning tool and relevant institutional base recommended.	6.1 Recommend the relevant institutional base(s) for the KUMINFO system 6.2 Update the relevance and determine the recipients of the information meta-database and make it available to them.		Partially attained. The pilot system was only available in the latter stages of the project and assessment as a planning tool will follow. Recommendations for the continuing institutional bases for KUMINFO discussed with programme management.

SUMMARY

On the basis of the above detailed assessment and the correspondence between the two systems of reckoning it can be stated that the majority of the planned activities and outputs were achieved. Taking the summarised research outputs as the definitive system we can provide the following explanations.

Framework for improving land management and livelihood systems, particularly for low-income peri-urban inhabitants

Relevant logframe attainments : for the seven outputs and 22 activities listed, there are six assessments of attainment, three assessments of partial attainment and four assessments of non-attainment. It may be concluded that this very extensive portfolio of work attained a strongly positive balance of achievement. Where the assessments are negative the explanations provided reflect for the most part over-ambitious targets which were to a certain extent imposed by (previous) programme management. It is interesting to note that Reviewer 1 appears to be agreeing, under "other remarks" that some of the outputs were beyond the capacity of this project to achieve.

Response to some points made in the knowledge consolidation project (R7549)

Security of access to land was considered a key issue throughout the project. This was an area of research addressed by the Project Co-ordinator and socio-economist through analysis of the stakeholders, procedures and mechanisms involved in access to land, using qualitative and quantitative data. One aspect that we would suggest might prove fruitful for further research is a comparison of how and why land tenure systems impact inhabitants of other peri-urban areas. We did study literature relating to land tenure in general and West Africa in particular, as background to the research, but literature on peri-urban situations is sparse. We had hoped to place the Kumasi case study in a more international context by involving another international land tenure specialist. However, this was not possible during the project.

Characterisation of the poor in terms of their position within communities was addressed specifically by the wealth ranking study, where key informants from the four study villages discussed the characteristics of poverty and wealth, and ranked their fellow villagers in terms of relative wealth. Further information on the characteristics of the poor were gathered in the Community Groups Study (which looked at membership of poorer people of community-based groups); the Homelessness Study; the Household Survey (which included data on poverty-related factors such as education, housing, facilities), and the Family Case Studies (which traced the changing fortunes of family members from the oldest to youngest generations).

Throughout all forms of research, information and attitudes expressed by men and women were recorded. Information from each study village was also recorded separately. Although some of the information from all the villages was combined in the FTR reports, it is available for separate analysis.

No data was collected directly on individual or household income or expenditure. The reasons for this and the rationale behind using a wealth ranking approach are discussed in the FTR. Subsequent to the FTR, further analysis has been done (for DFID methodology project R7033), combining the wealth ranking data and the household survey data (Jeffries, Warburton, Oppong-Nkrumah, Fredua Antoh, 2000). This analysis used the case study of the village of Aburaso. The analysis could be extended to the other 3 villages.

There is scope for further investigation of poverty. For example, we know from the research so far that there are flows of income and expenditure between family members, and

from one enterprise (e.g. farming) to other enterprises (e.g. trade), which play an important role in supporting the poorer individuals and providing opportunities for them to improve their situation. However, we have not attempted to quantify these. Any further study which looked at expenditure and income would require sufficient resources to undertake this, given the complexity of multiple income sources available to peri-urban inhabitants. One other approach might be to use the factors identified by the existing studies, such as female-headed households, lack of education etc. as proxies for targeting further research.

One other area of research that might be considered, would be to investigate further how the local authorities define, prioritise and tackle poverty issues in their area.

The exploitation of most of the available natural resources has been covered, although water was not dealt with to any great extent in this project, it being addressed in R7330, Kumasi Watersheds, which was a "spin-off" originally suggested by this project's lead research team. The KAR project R7132 on small-scale irrigation also contributes to understanding of the exploitation of this natural resource.

Changing intra-household responsibilities, the current status of the traditional support network, access to credit, and a detailed examination of the job market are all issues which can be addressed in the further knowledge project, R7854. However, R6799 did have quite a lot to say about the strength of customary leadership and there is probably no need to specifically address this point in future studies. We would suggest that further work on intra-household responsibilities start with information from the Household survey and the family case studies as baseline data, as these contain detailed data on houses, households and individuals.

Frameworks for analysis, leading to understanding, of agricultural and natural resource utilisation (including urban Kumasi), *and*
Strategies for sustainable agricultural productivity

The **frameworks** for analysis were set up under logframe outputs 2.1.to 2.3 and 3.1, for which all assessments are of attainment of outputs. The **understanding** was achieved in these outputs and also outputs 2.4, 2.5., 3.2 and 3.3 for which the assessment of one output (2.4) is qualified.

It is acknowledged that the low yields obtained in the tomato crops in the nutrient application and Mucuna trials constitute in a sense the "failure of all the field experiments", as stated in R7549 (although the yields of okra in the on-station nutrient balance trial were within the expected range). Due to factors for which the project agriculturalist must take some responsibility, little or no scientifically sound data can be derived from the work. However, the trials can be considered a success in that they provided a forum for the generation of interest and discussion amongst peri-urban farmers, and led directly to the stimulation of an extension exercise, on the use of peri-urban waste products. The economic analysis and discussion in the report of the poultry manure trials provides some justification for this extension effort.

The use of poultry manure, and the production and use of compost, constitute the **strategies** for sustainable peri-urban agricultural productivity developed through this project. Outputs 2.4 and 2.5, also output 2.6, assessed as partially attained, refers. These strategies were selected, as was the production system, largely on the basis of the recommendations of the expert consultant contracted to provide output 1 of the soil fertility work. The poultry manure extension exercise records that the strategy was generally well received by farmers and that problems of adoption, in particular transporting the manure, were addressed at a workshop attended by farmers and project staff and solutions put forward. The compost making and use had clearly caught the imagination of the farmers at the village where the

work was concentrated and had led to the setting up of a farmer field school. There would need to be a follow up to see if the interest has been sustained after the end of these concentrated extension efforts.

Proposals for development of strategies to improve urban natural resource utilisation and agricultural productivity did not progress beyond the report and workshop stages and are therefore (outputs 3.4, 3.5) assessed as partially or not attained.

Framework for analysis of planning constraints and information needs

The assessment of output 4.1 is of attainment or exceeding attainment. A considerable body of knowledge which enables an understanding of the planning constraints and information needs for the peri-urban area has been gained and reported on.

Strategies for improved planning processes, focusing on natural resource and environmental issues

Outputs 1.4, 1.5 and 4.1 are assessed as attained or largely attained. On page 216 of the FTR a brief recommended strategy for an improved planning process, focusing on natural resource and environmental issues, is put forward. Given the limited number of CBOs, NGOs and environmental pressure groups found to exist in the peri-urban interface or concerned with environmental issues, this meant an initial concentration on the district assemblies and other public sector organisations. The main focus of the planning work was to try to expand the knowledge base of the district assemblies, identify weaknesses in their current planning processes, and try to educate/train the planners about this in a series of workshops. Many Unit Committees were also found to be actually concerned with environmental health or other environmental issues, often on a self-help basis.

Although not labelled as a strategy, in effect the research and development recommendations in Appendix 2, (FTR, pp.240-243) represent a series of activities which together could form a strategy. The strategies proposed for improved planning processes are to overcome existing policy-making and planning weaknesses.

It is not clear what Reviewer 1 expects under strategies for improved planning processes. Out of the various interpretations of planning processes, Reviewer 1 seems to have a very specific and partial interpretation of planning processes - perhaps emphasising the participation of the community in planning (existing weaknesses with this are pointed out in the Kokor Report, which appeared in the Inception Report volume 2, and in the FTR, pp.196-197). Community participation in planning was explored and implemented under the PLUP exercise assessed as the attainment of output 1.5.

The suggested Activities in the Inception Report (p.114) called for a Planning Forum to be convened so that the Ghanaian planners could discuss the approaches to be adopted for the proposed strategic plan for the city region as the first steps towards their preparation of a strategic plan. They might then have been able to improve the current planning processes themselves with some guidance perhaps from the project. This proposal was not taken up by the programme management, possibly because it may have been felt that this would have led to a development project rather than a research project, but this would have been more in keeping with meeting some of the reviewer's comments.

Information systems to aid research and planning

Outputs 4.2 to 4.6 are assessed as all attained with the exception of a follow-up on the use of the GIS as a planning tool. This aspect of the GIS development is to be the subject of further NRSP programme management funding. The future maintenance and sustainability of the GIS in Kumasi is being addressed by the Watersheds project.

Part 2: Generic value of the research

It is perhaps an inevitable consequence of adopting a case study approach that its generic value should be brought into question, and it might be expected that this would have been carefully pre-researched prior to the selection of the case study cities. Again, the separately commissioned "Concepts and methodologies" study might have been expected to shed light on this. Inevitably each peri-urban area has its own unique features which will make it difficult to generalise. Also, the absence of work existing in other PUI areas make it difficult to make generalisations. Further research would be able to shed light on this.

For the record, the following summarises the conclusions on issues affecting livelihoods of people living in the peri-urban interface as brought up by the research in the selected case study cities of Kumasi and Hubli-Dharwad. This is extracted from a paper produced jointly by the two project leaders for the DFID in 1998 on the subject of similarities and differences between the cities.

Gender dimensions

- **women displaced and disadvantaged**
- **contrasts in distribution of opportunities**

Livelihoods and employment opportunities are closely related to population pressures and in Kumasi it has been found that more women are farmers than men in the peri-urban villages and that they are particularly vulnerable to losing their farms to residential development because women's farms are often those closest to the village centres, which form the foci of new housing developments in most cases. Their ability to invest in inputs is constrained and the lack of availability of capital for investment in agriculture (and other livelihoods) is top of the list of farmers' constraints.

In the Hubli-Dharwad city-region, participation in the labour force as a whole has increased particularly rapidly for women in the three sub-districts nearest the city. Given that the number of female non-farm workers has increased much more slowly than male, most women were finding work in the lower paid farm sector. Literacy levels were studied, as an indicator of well-being/poverty. In general male rates (around the 50% mark) were more than double female in 1981 and almost double in 1991. Poverty in the peri-urban areas thus has a strong gender dimension.

Soil fertility

- **important livelihood threat in Kumasi**
- **less clear influence in Hubli-Dharwad**

Soils of the Kumasi peri-urban area are known to suffer from nutrient deficiencies, acidity and low levels of organic matter. Peri-urban farmers recognise that soil fertility decline has been a major agricultural change in the last fifteen years, also the decline in the length of the fallow period, and it is clear that many farmers recognise a cause and effect relationship between these two factors.

Most farmers in the Kumasi peri-urban area have responded to this situation in one of two ways. The practitioners of traditional food-crop bush-fallow farming systems, under pressure, carry on as before as long as they can, then give up farming altogether when the soil fertility is exhausted. On the other hand, some intensification in vegetable and some cereal cropping systems has occurred, often by younger men. Such intensification is usually generated by the use of externally derived inputs such as fertilisers and herbicides. Whilst livestock play an important and possibly increasing role in peri-urban farming there is little evidence of use of organic manures.

In contrast, in the Hubli-Dharwad peri-urban area, whilst declining soil fertility is reported as a constraint, its significance is less clear. This is at least partially due to the differences in inherent fertility between the two distinct soil types in the area. Further detailed investigation and analysis is required before it can be asserted that there is a significant effect of declining soil fertility in the area.

Institutional challenges and responses

- **lack of co-ordination**
- **lack of environmental planning**
- **contrasts in *de facto* planning authorities**

The peri-urban interface offers a challenge to the classification into urban and rural for planning purposes and this has been met somewhat inadequately in both city-regions.

In Kumasi, as in the rest of Ghana, planning co-ordination and linkages between villages and districts is weak and, despite the existence of village development committees, the *de facto* decision-takers on urban expansion are in most cases the village chiefs. Village development planning is weak or non-existent, and there is limited community participation. Chiefs release land without reference to a long-term community development plan, often with no reference to environmental issues: they are no longer custodians of tradition, rather catalysts of change. At district level there have been different methodologies applied by the different district authorities. Some of these methodologies may be seen to be more likely to foster a sense of ownership of the plan than others, but on balance there is little evidence for such a sense. Finally, no strategic regional planning is taking place.

In the Hubli-Dharwad area, planning is currently divided between the Hubli-Dharwad Urban Development Authority (HDUDA) and the Dharwad Zilla Panchayat[1] (DZP). The HDUDA is concerned with physical or town and country planning, leaving the Hubli-Dharwad Municipal Corporation responsible for the implementation of these plans. The emphasis is on accommodating urban growth rather than making specific land use decisions as part of an environmental management plan.

In contrast, the Zilla Panchayat is concerned with socio-economic planning. The various Gram Panchayats[2] within the district make requests for funding, and the DZP allocates resources to each department in accordance with Central and State plans. The Village Development Committees of the Gram Panchayat are also concerned with socio-economic planning and the allocation of resources to specific projects.

The present planning systems lack effective means of co-ordination. Problems arise from the limited inter-institutional co-ordination between the urban-based, long-term, physical planning approach of the HDUDA and the rural-based, short-term, socio-economic and non-spatial planning approach of the DZP. This has been recognised by the State Government which has set up a (not fully accountable) District Planning Board with representation from all the local planning authorities.

Conclusions

From the research undertaken to date, it appears that the people living in the peri-urban interface in both case study areas are beset by similar natural resource management problems, with varying emphases and degrees of severity. The research provides greater understanding, improved technologies and strategies for peri-urban communities and agencies with responsibilities for NR management within the peri-urban interface.

Project researchers have attended various international workshops and participated in an e-conference to bring the findings of the project to other researchers and development professionals and peri-urban stakeholders. DFID has used project findings in its various reports and publications. In the sphere of agriculture, peri-urban issues tend to be lumped together with and given less attention than urban issues. Perhaps the NRSP might consider organising an international workshop specifically to grasp the issue of on-going changes in livelihoods which particularly characterises the peri-urban area.

[1] Zilla panchayat: District council
[2] Gram panchayat: Village council

Part 3: Progress in GIS development during and beyond the KNRMP.

1. During KNRMP project life

The KNRMP collaborated with R6880, GIS development project[3], throughout, and some of the project outputs from R6880 were eventually used in KNRMP- for example the ADP data. Also some of the routines developed under R6880 have been incorporated into KUMINFO, for example producing printed maps to scale. However most of the routines were not produced in a way that were easily transferred to KUMINFO and were presented as stand alone demonstration GIS's by R6880.

Researchers from the two projects have collaborated in producing papers at conferences.

With respect to the ADP - the following limitations were keenly felt by KNRMP researchers:

a) No accurate image index was supplied until after the end of both projects and much work was done correcting the inaccurate index supplied.

b) Twain drivers to enable the images to be used at full resolution were not supplied with the compact discs of data to KNRMP and had to be requested.

c) Similarly the compact discs of data were given to both NRI and IRNR with no software to acquire the data (Paintshop Pro) or to geocorrect the imagery. Software was available at NRI as part of the corporate GIS/RS facilities. Software at IRNR has recently been supplied by the R7330 project or donated by NRI (Paintshop Pro).

2. KUMINFO beyond the KNRMP.

The future maintenance and sustainability of the GIS in Kumasi is being addressed by the RHBNC[4]-managed R7330 project. The project is working with IRNR on a business plan which is aimed at making the system self-sufficient by March 2002

The GIS can be seen as potentially a generic tool that could be applied elsewhere. RHBNC & NRI are developing a project proposal with the Ghanaian EPA (Environmental Protection Agency) to use the system in a water monitoring pilot project that will be nation-wide. The programmes and techniques developed are transferable to any other situation.

With regard to planning, although considerable work has been done to establish the frameworks of the applications required, a detailed system analysis of the needs of planners and work to be implemented would be needed to further the use of the system in specific peri-urban planning situations.

[3] Full title "Development of methods of peri-urban natural resource information collection, storage, access and management".
[4] Royal Holloway and Bedford New College, University of London

APPENDICES

Appendix 1: Inventory sheet

Item	*Make & Model*	*Serial No.*	*Date received*	*Purchase price*	*Location*	*Disposal to*	*Disposal date*	*Authority*
Computer CPU (GIS use)	Compusys 32004967	956606	July 1997	£9872 incl. ARCVIEW	IRNR Kumasi			
Keyboard	Microsoft E03786 NP5	KBN97 02004711			"			
Monitor	Vision Master Pro21	6013786			"			
Mouse	Microsoft Intellimouse	61043003			"			
Printer	Hewlett Packard 690C	SG71KIP25G			"			
UPS					"			
Computer CPU (GIS use)	Compusys	956605	July 1997	£9872 incl. ARCVIEW	IRNR Kumasi			
Keyboard					"			
Monitor	Vision Master Pro21	6013792			"			
Mouse	Microsoft Intellimouse	00891301			"			
Printer	Hewlett Packard 690C	E572K1128Y			"			
UPS					"			

Item	*Make & Model*	*Serial No.*	*Date received*	*Purchase price*	*Location*	*Disposal to*	*Disposal date*	*Authority*
Computer CPU	Compusys 5133 2Gb MT Pentium	956612			LARC (now ILMAD) Kumasi			
Keyboard	Microsoft Natural keyboard	KN9702004701			"			
Monitor	Compusys 17" CRT	(S) 2H816700343	May 1997	£3090	"			
Mouse	Microsoft				"			
Printer	HP Deskjet 690C	(S) SG71L1P067			"			
UPS	APC Back-UPS Pro BP650 IPNP	GB9713269532		£358	"			
Printer	Canon BJC70	XAU12294	26/3/97	£170.00	NRI & Kumasi			
GPS	Garmin 12XL	35507688	14/3/97	}	IRNR Kumasi			
GPS	Garmin 12XL	35507689	14/3/97	}£766.82	UoNottingham			
GPS	Garmin 12XL	35507690	14/3/97	}	IRNR Kumasi			
Scanner	HP Deskjet 6100c		June 1998	$1106	IRNR Kumasi			

Appendix 2: Research or development recommendations relating to institutional issues concerned with planning and environmental aspects.

1. PLANNING

(a) Practical Applications Utilising Information:

1. Assist planners to update databases and produce maps for district assembly, unit committees and area councils for planning and environmental management purposes, and provide guidance on how this information can be used. Assist in the use of the April 2000 Population Census of Ghana by the district assembly planners in the Kumasi City Region. In particular, increase the utilisation and coverage of information on renewable natural resources and environmental issues. Build on KUMINFO to ensure that it becomes a practical planning tool.

2. Participation in the preparation of a strategic regional plan for the Kumasi city region, ensuring adequate consideration is given to environmental issues, including those affecting environmental health. This would involve extending KUMINFO to cover peri-urban areas within KMA as well as extending the databases and maps to urban areas of KMA.

3. Develop procedures for the provision of information to be held and developed by individual villages - facilitating a two-way exchange of ideas and information with district assembly departments. The provision of planning-related information by the planning officers has shown that close links and consultations with key grassroots informants are weak. Guidelines are needed both to assist unit committees or other key village informants to handle, store or collect information of concern to their communities, as well as for the district assembly planners and policymakers to assist with this decentralisation of information-gathering process, thereby contributing towards the further development of community participation.

4. Update and extend the register of layout plans, by digitising each plan for storage and display in KUMINFO. Databases to be developed showing the total number of plots demarcated, the date prepared or updated, and the plots allocated and developed, as a series of computer maps for the district. Assistance would be provided in developing monitoring procedures for the implementation of layout plan proposals. Help identify where new layout plans are needed, fitting this into a strategic planning framework.

5. Extend the trotro survey to cover all peri-urban villages by enumerating all vehicle movements within the Kumasi city region beyond the built-up areas of the city, and conducting more detailed interviews of samples of passengers. This might enable the feasibility and implications of using alternative conventional bus services to replace trotros or taxis in order to reduce traffic congestion and air or noise pollution problems within the city. Comparisons of the results could be made with other, more direct, indicators derived from sample surveys of changes in occupations and activities in peri-urban areas, including
(a) population increases measured by the April 2000 Population Census,
(b) the value of land sales, and
(c) the number of plots which have been demarcated or allocated, with houses completed and occupied, including the characteristics of the new occupants.
In addition to the development of a monitoring function for the activities of the town and country planners, the use of transport data to define peri-urban activities has wider applicability to cities in other parts of Ghana, Africa or the world.

(b) Monitoring and Evaluation of Environmental Impacts and Effectiveness of Policies:

6. Extend the pilot study of Unit Committees so a comprehensive database is built up on each one's environmental and other problems, its development priorities, and current activities, including the reasons why some unit committees are relatively inactive, and why some projects are not being started or completed.

7. Examine the progress and weaknesses of self-help communal labour projects organised by the unit committees or other village organisations.

8. Conduct more detailed evaluations of the Poverty Alleviation Fund in peri-urban areas, including the spatial allocation of its assistance, the impacts of the projects on the beneficiaries, and the identification of specific difficulties which preventing the project objectives being achieved - particular attention should be paid to projects intended to use or process renewable natural resources. This might also include studies of producer co-operatives in the peri-urban areas of Kumasi, and how they can be assisted to directly supply the Kumasi market and meet the region's demand for food, probably in collaboration with the market queens for each commodity.

9. Test the hypothesis that peri-urban areas have been starved of resources under 'top-down' policies, and examine whether they are still relatively neglected under the decentralisation programme.

(c) Changes in Planning Activities:

10. Extend the Participatory Land Use and Environmental Planning pilot projects to other villages within Kumasi's peri-urban areas in order to develop a technical manual, guidelines or checklist on the issues and considerations to be discussed during village-level participatory planning and environmental management activities.

11. Provide an advisory role in the development of activities or measures to involve genuine grassroots participation in planning and environmental management. This might take the form of action research in which the activities of the collaborators are observed.

12. Help establish a monitoring system on the implementation of environmental and other projects proposed in the 1996-2000 medium term district development plans for the peri-urban areas in the Kumasi City Region, including the roles of different institutions or sponsors, and the identification of the reasons for failures to implement. Evaluate the implications and impacts of these projects.

13. Foster the development of a Joint Development Planning Board for the Kumasi city region, and assist in the development of practical procedures and policies.

14. Extend the work on linkages between institutions concerned with environmental issues to including different levels of government, the private commercial sector, NGOs and the voluntary sector. Help identify the scope of potential privatisation of public services.

15. Contribute towards the development of integrated teams to prepare sectoral analyses or project proposals. Encourage the town and country planners to broaden their interests into forward planning so they can work more closely with the economic development planners, and participate more fully in various sectoral sub-committees involved in the preparation of the next district development plan.

16. Assist in the development of a more proactive form of planning, including facilitating partnerships within the city-region on the land release process. This might bring together the Asantehene's Office, Lands Commission, district assembly planners and assembly members, and the communities.

2. ENVIRONMENT

17. Assist the EPA and a selected district assembly in the preparation of a District Environmental Management Plan, covering environmental problems encountered by individual villages, together with proposed policies to solve these problems. The use of Kwabre District, for example, as the pilot project could provide lessons on the approach to be adopted which would be applicable to other districts within the Kumasi City Region, as well as to other districts of Ghana and other peri-urban areas in Ghana and Africa.

18. Examine the operations of Village Health Committees and Water and Sanitation Committees to see how far they are able to analyse health needs, particularly related to environmental health criteria. This study might also incorporate the role of NGOs or community based organisations in the provision of health services.

19. Examine solid waste management activities and pollution control measures in peri-urban towns and villages, including the peripheral settlements within KMA.

20. Examine policies intended to improve domestic water supplies, and the local involvement in these schemes.

21. Contribute towards the preparation of district strategic environmental sanitation plans.

22. Assist in resolving the differing perceptions on priorities for environmental action among different groups or individuals within a district.

23. Help the Environmental Protection Agency update the Guidelines issued by its forerunner, the Environmental Protection Council, for district environmental management committees and community environmental committees, and assist in developing capacities to prepare land use plans.

24. Contribute towards developing specific regional and/or district policies to be developed on sand winning.

25. Help develop the application to the Kumasi City Region of the Environmental Planning and Management Approach (used by Urban Management programme and other UN agencies, including the Sustainable Cities Programme), and Local Agenda 21 activities.

3. GUIDELINES/TECHNICAL MANUALS

26. Production of technical manuals or guidelines on appropriate techniques for district development plan preparation, including ensuring that environmental considerations are taken fully into account.

27. Preparation of technical manuals on developing the national settlements strategy, giving appropriate emphasis towards environmental issues and to meeting the needs of peri-urban areas in Kumasi and other major cities in Ghana.

28. Guidelines on incorporating environmental aspects more fully into the process of preparing layout plans by the town and country planners, and increasing community involvement in this process.

29. Assist the district town and country planners to engage in forward planning through the preparation of guidelines or technical manuals on plan preparation and implementation procedures.

30. Help revise the Ghana Planning Standards so they can be more applicable to peri-urban areas.

31. Assist the regional and district institutions in the Kumasi City Region to contribute towards the preparation of guidelines and technical manuals, identified as programme activities in the National Medium Term Development Plan.