NATURAL RESOURCES SYSTEMS PROGRAMME

PROJECT REPORT[1]

DFID Project Number

R7330

Report Title

Peri-urban natural resources management at the watershed level, Kumasi, Ghana. Scientific Report.

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5 The Development and use of Geographical Information Systems in natural resources research in the peri-urban area of Kumasi

5.1 INTRODUCTION

Kumasi, the second city of Ghana continues to undergo rapid expansion, especially of residential areas around the fringes of the city. Rural villages up to 40 km from the city centre report increases in new housing over the last 15 years using up land that was previously used for agriculture. The growth of Kumasi affects the population balance in the villages and the way in which villagers earn their livelihoods. This in turn affects the management and utilisation of natural resources such as water, land, sand and stone, and forest products.

In order to address these issues, a series of research projects have carried out in-depth studies in the peri-urban area. A base line study led to a three-year research project in the Kumasi city-region (R6799: *Kumasi Natural Resource Management Research Project*). The research team on R6799 consisted of scientists from the Kwame Nkrumah University of Science and Technology (KNUST), Kumasi, the Natural Resources Institute (NRI, University of Greenwich), UK and Nottingham University, UK. Underlying and utilised by much of the research in R6799 was an integrated information system for peri-urban natural resources systems research based on PC Geographical Information System (GIS) technology - KUMINFO.

During the course of R6799, a further DFID-funded project was undertaken*:* R6880*: Development of Methods of Peri-Urban Resource Information Collection, Storage, Access and Management* (Cranfield University and GDS Ltd). This project set out to demonstrate the application of satellite imagery (a SPOT panchromatic image acquired in December 1994), and aerial digital photographs (ADPs) (which had been acquired over much of the city and immediately contiguous area in December 1997) to peri-urban systems research. A main thrust of this research was to develop user-friendly information systems to inform landuse planning at the village level. These systems were tested at village level by project staff , and met with mixed success (see Final Technical Report of R6880 and D'Souza & D'Souza 2000; Thomas *et al* 2000; Taylor *et al* 2000).

Unfortunately, the ADPs had been flown lower than originally anticipated due to persistent cloud cover during the designated aerial survey period. Although ground resolution was greater as a result (down to a nominal 23 cm), stereoscopic coverage was lost and there were some local gaps in the coverage. Most of the urban area was covered, but coverage of the peri-urban zone was relatively restricted. Further, image correction to the Ghana National Grid had not been undertaken, and this caused subsequent problems (Thomas *et al.* 2000).

During the R7330 phase of the project, the KUMINFO system has been extended to include several non spatial databases, and to become a broader information system. Steps have also been taken to promote sustainability of the system

This report covers the work done during the R7330 project only, previous developments and results have been dealt with in the final reports of R6799 .

5.2 DATA ISSUES

The major change made to KUMINFO during R7330 has been to include new datasets including working databases and databases that are not suitable for visual spatial analysis. This has resulted in KUMINFO (version 3, User Manual produced in February 2002) becoming a more inclusive information system, in effect expanding it beyond the strict boundaries of GIS to become an integrated information and retrieval system.

Following this, as a general philosophy only completed datasets have been formally incorporated into the GIS Metadatabase, and Table 5.2.1 lists all such spatial datasets developed and available in the KUMINFO system

during the current Project. Some of these data sets are held by the KUMINFO computers, although as they are 'live' files and being updated/augmented they are not formally incorporated within the KUMINFO3 system.

The user manual has been revised to take account of the additions and changes (J Pender, 2002)

Table 5.2.1 New data sets available in the KUMINFO system from Project R7330

Description
Index of adp image centre points
Index of areas covered by geocorrected 1995 aerial digital photography
Index of areas covered by geocorrected 1997 aerial digital photography
Urban growth between 1995 and 1999 as indicated by satellite radar data
Water sampling sites
Positions of schools participating in water quality monitoring
Villages used in watershed management studies
Position of watershed between the rivers Oda and Ofin
50 ft digital elevation model (corrected from previous version provided by GDS)
Project Village Characterisation Survey
Project Village Water Characterisation Survey
Preliminary census 2000 data for Ashanti Region
Ghana wide preliminary census 2000 data
Hand dug wells
River order analysis
Development plan for Esereso
Development plan for Maase
Development plan for Tabuu
Development plan for Duase North
Development plan for Duase South
Development plan for Sokoban
Positions of water boreholes
Borehole log information
Rainfall data
Water quality data: Project monthly data
Water quality data: MSc data (O. Poku)
Water quality data: short-term data (Student projects)
Water quality data: miscellaneous data
River Stage/discharge data
A bibliography of literature related to natural resource management in the Kumasi peri-urban area
A list of environmental organisations operational in Ghana together with contact details
'Ghana at a Glance': coverage

Note: The 'Ghana at a Glance' coverage comprises over 20 maps at the nationalscale of basic physical variables.

The databases added to the system are of two types. Firstly there are one-off surveys/ project results. For example, the Watershed Village Characterisation Survey (WVCS) was a one off survey, but was not designed to hold data that are immediately mapable. It is possible to access these data from within KUMINFO3, but the database is held separately from the Metadatabase along with other original databases collected during previous projects (household survey, planning, trotro use, urban gaps agriculture, VCS. The second type are datasets which are ongoing and dynamic. These datasets have tables in the Metadatabase and are accessible by buttons from within KUMINFO3. These datasets include a Bibliography of literature relating to NR management in the Kumasi peri-urban area, or analogous areas elsewhere; and a Directory of environmental organisations operational in Ghana together with contact details. It is envisaged that datasets such as these will continue to be updated by KUMINFO staff as new information becomes available.

Datasets such as the Bibliography and the list of environmental organisations are designed to enable users to search using authors, placenames and keywords; and the results printed out or saved to another document.

5.3 MAINTENANCE OF THE INFORMATION SYSTEM

KUMINFO3 is based on commercially available software (Arcview, Spatial Analyst, Image Analyst and the Access database) and running on NT4 or an equivalent operating system. It is run in Kumasi by a GIS co-ordinator and a data manager with parallel systems in the UK at NRI (until July 2001), RHUL and Cranfield University.

KUMINFO now runs on Access 2000+. Most modern computers will have enough memory and hard disc capacity to run KUMINFO3 successfully, and the only constraint is that it must have an *intel* chip. The system requires MS Office Pro, Arcview 3.2x and Spatial Analyst software. The system was designed to run on Office 97, but can be run on Office 2000, for example on either Windows 2000 or Windows ME operating systems. The principal system held at IRNR, Kumasi is curreently running on Windows NT and 2000.

5.4 UPGRADE OF SYSTEM

KUMINFO was first established in 1997 and eventually it became obvious that an upgrade of the system became necessary. The principal problem related to the uncorrected nature of the ADP. Accurate geocorrection of this imagery was necessary if accurate ground plans were to be drawn up from the ADP. This had not been accomplished through either R6799 or R6880, and a significant proportion of the NRI Data Manager's time allocated to R7330 was being spent doing this task manually rather than automatically. Increased demands for using the ADP data in project R7330 was one of the driving forces here, though the imagery was being used in the first instance in the uncorrected mode for field orientation at and around water quality sampling points. The original KUMINFO system did not have the optimum software for geo-correcting, mosaicing and analyzing this valuable dataset. A report commissioned by the project (Pole 2000) suggested that the Arcview extension Image Analyst was the most suitable software for these tasks. Also producing the images required increased storage and increased CPU capacity. These two issues were addressed by the purchase of Image Analyst for the KNUST laboratory and also a new computer with increased storage and memory capacity (purchased summer 2000).

In order to improve the output capability of the system an A3 printer was also purchased in mid-2000 together with an A3 laminator. In a humid climate like Ghana, lamination makes the use of maps in the field a practical prospect.

This upgrade should allow access to the data for the foreseeable future, though more efficient products will undoubtedly come on the market in due course.

5.5 DATA MANAGERS AND STAFFING ISSUES

Data managers were nominated in both the UK (at NRI) – Mrs. Judith Pender - and in Kumasi – Mr. Kingsley Boateng. These persons were 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. The installations in RHUL and Cranfield University have Donald Thompson and Graham Thomas as managers.

The staffing issue has proved to be a difficult one.

IRNR

During the course of the project, and according to budget, there has only been one part visit and one complete visit to Kumasi by the UK data manager. With the benefit of hindsight, this has proved to have been inadequate. Recurrent delays in producing outputs, and in actioning instructions, at the Kumasi end, contributed to progressive delay in fully realising the potential of the system. On the UK data Manager's second trip, in July 2000, a detailed work plan was agreed for both NRI and the data manager at KNUST (Table 5.5.1). However, it transpired that the data manager, Kingsley Boateng had by that time changed his employment status, moving from IRNR to the Geodetic Engineering Department, and the job schedule was not adhered to.

Table 5.5.1 Agreed KUMINFO tasks

Task	Place/person	Deadline	Achieved
ADP			
Index to metadatabase	KB,JP,DT	By Aug 2000	done
Print uncorrected images for field work	KB	14 August 2000	done
Check & send corrected images in UK	JP	July 2000	done
NRI to correct Maase & Duase	JP	7 Sept 2000	done
IRNR to geocorrect Atafua and Abrepo	KB	August 2000	Not done. Other areas done by VA. Remainder will be done as necessary
Water quality			
Spreadsheets & export to Uk	KB, VA	14 August 2000	done
Import into KUMINFO	JP, DT	End August 2000	ongoing
Boreholes & wells			
Borehole villages added to system	IRNR, KB,VA	July 2000	done later
Send borehole villages & info to NRI for UK distribution	KB, VA	July 2000	No
Excel spreadsheets	M.Campbell	Aug 2000	done
Model water table	RP, JP	15 Sept 2000	Base mo produced, requires uprating
Import into KUMINFO	JP	30 Sept 2000	Not done
Bibliography			
Sample text and indexing	VA	13 November 2000	done
Excel version and agreed rules	VA	30 November 2000	done
Sample input design, comments	JP	7 December 2000	done
Environmental Directory			
Field rules established	KB	13 November 2000	Done by VA
Final format agreed	JP, DAT	30 November 2000	done
Draft to JP & DFMM	KB	31 December 2000	Done by VA

Sustainability			
Short courses/training opportunities	IRNR: KB, VA	9 September 2002	1 day workshop (in series of planned training workshop JQS, VA
Costings policy	KB	31 December 2000	Drafted by JQS, V
WMF			
Text for KUMINFO	KB, VA	31 December 2000	Done by VA
GERMP			
Determine access and costings:	KB	16 November 2000	Eventually obtai from EPA, but not format expected
WVCS			
First look at data	KB	End July 2000	Not possible to n –decided by JP S 2001
Modelling			
Modelling water flows etc	NRI, RHUL		Started

In light of the fact that it was becoming progressively more difficult to obtain timely action from Mr Boateng, he was put on to a 'payment by results' contract, and a second person, Veronica Nana Ama Asare, was employed on a part-time basis as cover at IRNR at this time. Eventually when Mr Boateng left KNUST, Ms Asare took over his position as data manger.

The work programmes agreed involved the digitizing and production of new data sets as well as developing the Bibliography and Directory of Environmental Organisations.

NRI

Up until July 2001, the system was co-ordinated and managed by NRI (Judith Pender). However, extensive reorganization of NRI in July 2001, has meant that the two NRI staff working on KUMINFO (JP & Richard Pole) were no longer available, having left the institution.

The work programme agreed for NRI was largely completed apart from work on watershed modelling. Much of the formal budgetary time commitment was spent, as noted earlier, on geo-correcting a large number of ADP images, including those required by R7330 around key field activity points, and an analysis of software used for this task. Other work, such as inputs into the modelling work was not completed before work effectively stopped in July 2001. It should therefore be said that the potential for modelling watersheds anticipated at the start of this Project was not fully realised. The existing database in fact turned out to be less adequate than we anticipated, and the Project was not in a postion to provide resources appropriate to this. However, the potential for modelling is exemplified by the discussion in Section 5.9.

Database tables and forms were designed and implemented for the WVCS, water quality/pollution monitoring and the Environmental Directory and Bibliography. In addition, macros and queries were written to enable the users to easily search the Bibliography and Environmental Directory using authors, names and keywords, and the results printed out or saved to another document.

5.5.3 Data policy co-ordinating group

A data policy co-ordinating group consisting of Dr Quashie-Sam, Prof. Kasim Kasanga and Judith Pender was formed under the original R6799 project. This group considered issues relating to both digital and hard copy dissemination of outputs from the GIS including pricing. The group has not functioned under the present project, partly as Prof Kasanga was not part of the Project, but principally as it had effectively laid the ground rules for implementation. Ongoing and new issues of output dissemination were regularly discussed by UK Project staff on visits to Kumasi, and by email contact between visits.

5.6 RECOMMENDATIONS ON SUSTAINABILITY

IRNR has been developing a business plan for sustaining the system after the end of the DFID input. The latest draft received will be found as Appendix J.

In preparation for the post-Project future sustainable management of KUMINFO, a separate grant was awarded by NRSP in December 2000. Funding was provided for a LAN to link the KUMINFO laboratory with an adjacent suite. This has enabled the facilities of a sister project "Ghana/Canada In Concert", funded by CIDA through Lakehead University, Ontario, Canada, to be linked to KUMINFO. The In Concert project has 5 PCs running Windows NT and 2000, GPS with a community base station, 2 digitizers, plotters (up to A0) as well as ArcInfo and ERDAS Imagine processing software. With these linked facilities, and the effective implementation of the Business Plan, the new version KUMINFO should be self sustaining in the future.

Funding was also provided by NRSP for hardware upgrades, additional software, email subscription and a training visit to NRI and RHUL for Ms Asare.

Sustainability however, depends on the enthusiasm and foresightedness of those who remain in charge of the system in IRNR. The valuable nature of the data should be recognised, and effective communication to the range of stakeholders must be ongoing and progressive. Futher, a sensible charging policy should be determined for the use and supply of outputs. The data manager should also be allowed enough time and resources to develop the sustainability strategy and to actively update the data sets.

KUMINFO was the subject of a Case Study report under NRSP Project PD093: *Study of the Impact of Selected NRSP Project Communication Activities and Media Products* (Communication in Development, 2001). This focused on the R6799 remit of KUMINFO, although it was carried out by consultants from the University of Ghana during the currency of R7330, as a 'SWOC' analysis (Strengths, Weaknesses, Opportunities, Constraints). The report recognised the potential of the system in addressing the information needs of institutions and communities in developing appropriate natural resource management strategies in peri-urban Kumasi. The main criticisms of this report are that there has not been enough training and publicity for potential users and stakeholders, and that protocols for accessing information held within KUMINFO had not been developed and transmitted to potential users. This is now the responsibility of the Ghanaian data managers and is being addressed as part of the development of a sustainable business plan. The recommendations of the Case Study report are commended to the KUMINFO managers at IRNR as constructive advice towards achieving sustainability.

There remains a sense, however, that KUMINFO was not fully accepted within the wider framework of R6799, being set up in a rather 'static' way; and was thus not fully geared up to the more interactive and research-oriented goals which both R6880 and R7330 hoped to achieve. The development of GIS was originally a separate project, but was subsumed under the R6799 umbrella. With the benefit of hindsight, this may have been suboptimal.

5.7 ADVISORY SUPPORT, ASSISTANCE AND TRAINING IN THE USE OF KUMINFO

An updated user manual has been prepared that helps the users access, query and output data from all parts of KUMINFO3. Prior knowledge of GIS systems is required, and this document is not intended to be a layman's user manual. It is, however, user friendly and Dr Quashie-Sam and Veronica Nana Ama Asare have developed a short course for GIS, Remote Sensing and GPS and, as part of the demonstration of the facilities available at IRNR, are able to introduce how to access and query data from KUMINFO3.

5.7.1 Training in Kumasi and UK

Training in Kumasi has continued throughout the project with both past and present data managers, during visits to Kumasi by the UK data manager. However time constraints on the Ghanaian managers during visits limited this training. 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.

In autumn 2000, Veronica Asare visited the UK for an intensive training course at NRI and RHUL. At NRI the training was undertaken by Richard Pole and covered

- KUMINFO familiarisation – including KUMINFO customisation – adding buttons and menus, attaching scripts, basic script structure, tool tips, APRs (Arcview project files)
- Introduction to the KUMINFO Metadatabase - Adding metadata. Introduction to Access – creating tables and forms, adding the Bibliographical info to the metadatabase, creating a form and table for the Environmental Organisations
- Introduction to the Aerial Digital Photography (ADP), Choosing a Watershed village study area and creating a mosaic of ADP for that village.

At RHUL, training and associated activities were carried out under the supervision of Donald Thompson and Duncan McGregor, and included

- Familiarisation with setup at RHUL
- Installation of KUMINFO3
- addition of entries to the KUMINFO-held Bibliography
- redrafting of the KUMINFO Sustainability Business Plan

5.8 ACHIEVEMENTS TO DATE

Recent achievements by the KUMINFO staff at IRNR include the following:

- preparation started to hotlink Watershed Management Framework text within KUMINFO
- maps prepared for interested collaborators and potential clients (eg CEDEP and R7995)
- One day familiarisation course (attended by 5 staff of IRNR and 15 staff of KNUST Medical School). At undergraduate level, the facilities have been in use since 2000 to upgrade and strengthen existing courses in GIS and Remote Sensing
- students from other faculties and staff who require training in GIS, remote sensing and use of GPS systems at a cost. Egs include training of foreign student on *Friends Word* programme; and staff from Planning Dept at KNUST
- print out ADPs (single or mosaic) of specified areas for interested clients (eg printed a mosaic of Aboabo for an Architecture student)
- liaison with partners in Cape Coast to draft tourist maps and ancillary tourist information. In final production stages
- collaboration with KNUST Medical School with research grant proposals for using GIS to determine distribution and vectors of disease in Ashanti Region.

5.9 EVALUATION OF MODELLING STRATEGIES

Detailed modelling of pollution dynamics in an area of highly variable land use and surface topography is a highly complex task. Data requirements are very intensive in terms of both spatial and temporal resolution of hydrological variables and topographic surfaces. The minimum requirements for meaningful modelling are:

- Large scale map coverage with 1:50000 as a minimum and 1:25000 or greater required for detailed two-dimensional determination of flow fields and sub-catchment delimitation.

- Flow discharge data for the main rivers flowing through Kumasi. Data from several gauges along a main stream section would be required to provide a base-line for flow accumulation estimation.

- Water table depths for a sufficiently dense network of wells to provide a means of accurately interpolating the ground water table surface in three dimesions to determine flow fields and directions.

- Daily-rainfall data, for more than one location, in each catchment area. Autographic data is required to determine the mean or maximum intensities required for runoff derivation as well as rainstorm duration.

- Soils porosity and infiltration rates under different vegetation densities and land cover types.

As detailed earlier, the available data either were not present in the expected quantity to fulfil all of the original objectives, and the Project's budget did not allow gaps to be filled. With hindsight, it is clear that the budget for NRI support was insufficient, and the redundancy of the key personnel during the Project further exacerbated this problem.

Nonetheless, we have been able to explore a number of directions, and create a numbe rof models which can be parameterised to afford significant insights into natural resource and water management in peri-urban Kumasi. Three examples are detailed below.

5.9.1 Topographic modelling and pollution transport

The ability to model the pollution dynamics of the Kumasi peri-urban zone are severely compromised by the lack of detailed map coverage of greater resolution than 1:50000. This prevents detailed DEM interpolation beyond this scale in a landscape characterised by dissected plateaux and erosion surfaces which has mostly subtle topographical variation with localised steep slopes marking the transition to stream floodplains.

Despite the poor resolution of the topographic data available for KUMINFO, we have been able to usefully model the flow direction fields for overland flow within the peri-urban zone. The objectives of this exercise were to:

- Define the flow direction fields for the peri-urban zone.
- Establish those areas likely to directly contribute overland flow (and thus polluted runoff) to the river channels
- overlay likely 'polluting activity point sources' to establish whether runoff from these sources is likley to directly compromise river water quality

The 1:50000 DEM is the highest resolution model which can be obtained from the topographic data available to KUMINFO. Figure 5.9.1 shows the DEM coverage created for the peri-urban zone. Note that the definition of small scale topographic changes, which is essential for detailed flow modelling and accumulation, is not apparent from this model. Arc view uses a Kriging interpolation algorithm to fit the surface to the distribution of points defined from the TIN. Arc View Spatial-Analyst was then used to define a slope field and aspect field from the 1:50000 DEM. This is shown in Figure 5.9.2. Waste site locations have also been overlaid as well as project villages and water sampling points.

This procedure shows the surface aspect for the area. Since water will flow down the steepest gradient available the aspect map can be interpreted as a model of overland flow direction fields.
Figure 5.9.3 shows a higher resolution aspect map of peri-urban Kumasi. The grey areas indicate locations of essentially zero or indeterminate aspect. These areas would tend to retain surface runoff and allow it to infiltrate into the soil. Hence, they could be assigned as 'storage' locations for surface runoff and 'sinks' for polluted overland flow.

Locations with aspects indicating direct inflow to the adjacent rivers would be direct pollution 'sources' in the wet season. If local activities led to the accumulation of contaminants on the land surface, they would be washed into the river during heavy rainstorms unless remedial measures were taken to prevent pollution diffusion. Appropriate measures might include vegetation strips or topographic barriers next to the river banks

to present overland flow reaching the channel and to allow for infiltration. Better siting of, for example, waste-sites would be a better solution still.

This type of approach has significant potential to aid land use planning but it should be stressed that the current model is of relatively low resolution. The aspect fields derived from 1:50000 contours are not as accurate as would be the case for 1:10000 coverage. Hence some of the grey, indeterminate, areas in Figure 5.9.3 are probably so-classified due to lack of data rather than true aspect.

Figure 5.9.1: Kumasi 1:50000 Digital Elevation Model

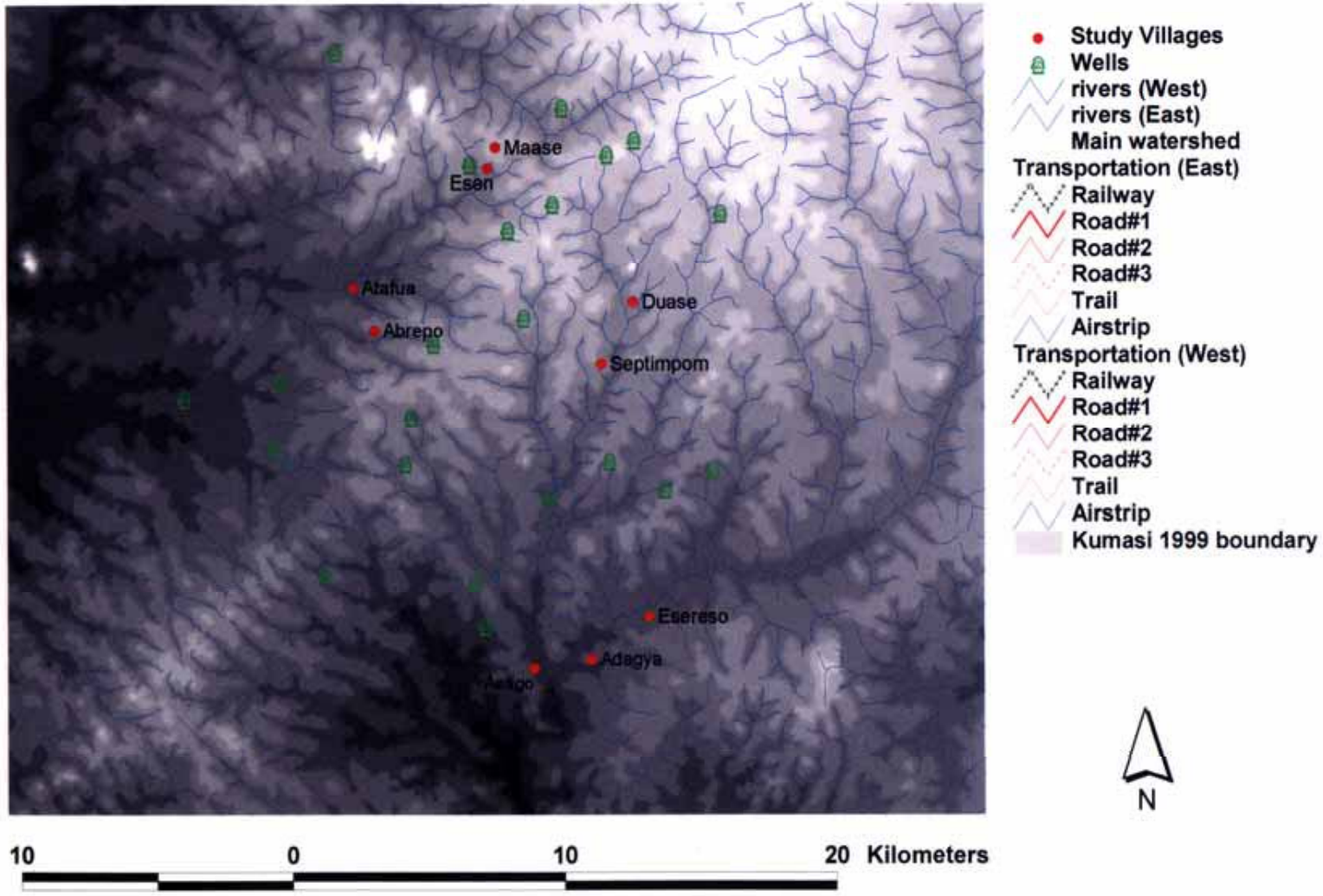


Figure 5.9.2 Kumasi: Topography - Aspect + Waste tip location

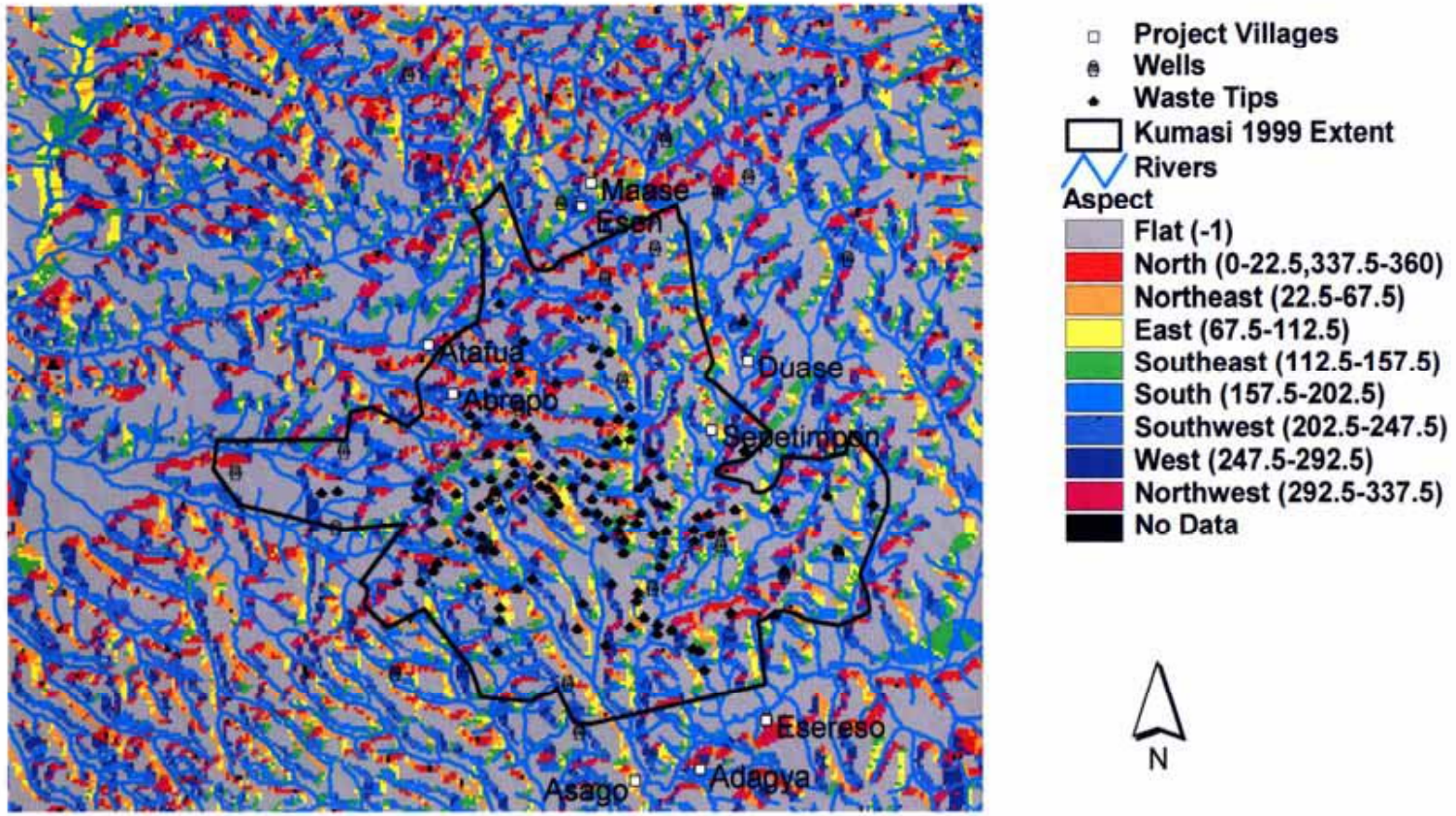
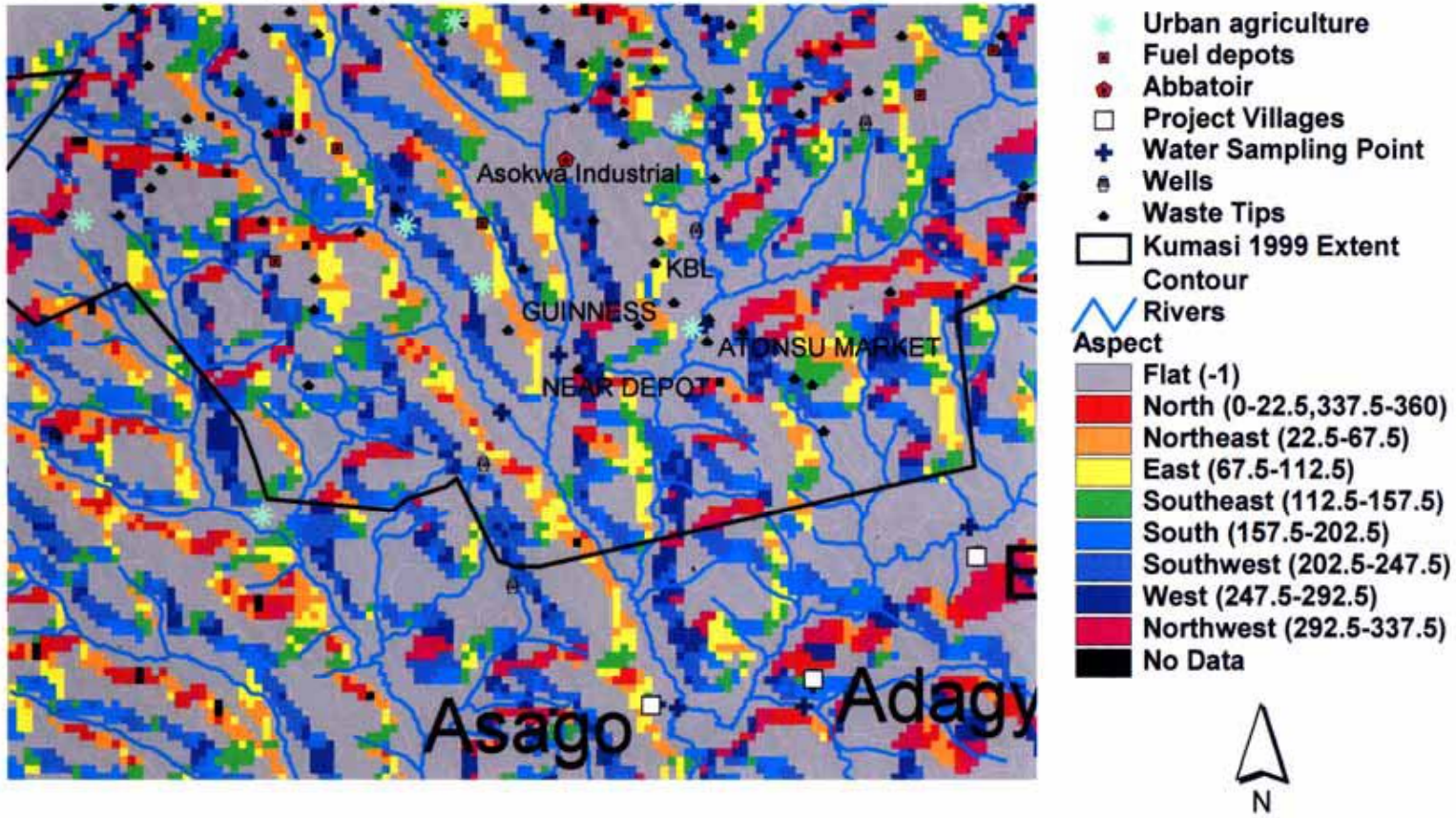


Figure 5.9.3 Topographic Aspect and Point Pollution Sources in S. Kumasi



5.9.2 Water balance models for village development layouts.

KUMINFO can also be used to inform a basic modelling approach to the consequences of rapid urbanisation and groundwater extraction. A brief summary of local groundwater conditions is provided as context.

Local Geology
The western section of Ashanti is underlain by granitic rocks of mid-Precambrian age. These rocks consist of granites, granodiorites and granite-gneisses. They are often highly fractured and intruded by quartz veins and aplitic dykes. To the east are sedimentary rocks (sands, shales, mudstones and sandstones) of the Voltaian group (Comwasan Consult, 1999) .

The extent of rock weathering, presence of quartz, aplite, pegmatite veins and the presence of fractured zones control the groundwater occurrence in this area (Comwasan Consult, 1999). Weathering is often accelerated by the presence of fractures, and the aquifers of the Precambrian rocks are found in the following contexts:

i) Weathered rocks where openings in mineral grains have allowed water storage and circulation. Water capacity is also increased by the fractured quartz, aplite or pegmatite veins.

ii) Fractured quartz, aplite and pegmatite veins in otherwise non-water bearing weathered rock.

iii) Fractured poorly weathered rocks.

Comwasan Consult (1999) note that aquifers in the Precambrian terrain have generally low transmissivities, are limited in areal extent and have irregular configuration. It is also noted that the Voltaian series has generally poor groundwater potential although some supplies come from fractures in the argillaceous horizons or from loose zones in the arenaceous members. (Comwasan Consult, 1999). Most of the aquifers are confined.

With rapid population growth of Kumasi in the last 30 years to over 1 million today, demands on the groundwater resource have probably increased by several orders of magnitude. In the peri-urban zone such pressures are accelerating. Evidence for the future increase in demand for groundwater resources is seen in the rapid process of house building in the previously rural environs. Most villages have a 'Layout' plan which is usually agreed by the Chief, who has control of plot sales, and may exercise this without the agreement of his community. the project has obtained layout plans of development plots for five locations in the rural-peri-urban fringe area of Kumasi (Figure 5.9.4). Many of the plots are already occupied and building has begun. Figures 5.9.4-5.9.6 show larger scale detail of the layouts to the north and east, and south respectively. Most dwellings will install hand-dug wells or boreholes for their water supply. Independent entrepreneurs usually construct hand-dug wells. However, the water quality from such wells is sometimes below WHO standards, particularly in floodplain areas within the city and downstream, and wells are often subject to collapse or contamination.

Figure 5.9.7 shows Esereso layout plan, which has been overlain on SPOT imagery. the yellow shaded area indicates the present village. White areas suggest areas where building had already begun in 1997. It is worth noting here that many building areas are on the river floodplains.

A 1998 survey of hand-dug well water quality, in districts around the Kumasi metropolitan area, shows that a high percentage of wells produce water which would require treatment for acidity, high iron content or coliform contamination. A significant number also have turbidity, total dissolved solids or manganese levels which exceed WHO limits, as shown by a report on hand-dug wells for the Community Water and Sanitation Agency (CWSA) (Anon, 1998) (Table 5.9.1).

Table 5.9.1: Hand dug wells around Kumasi: Percentages exceeding WHO limits based on CWSA, 1998. (Districts: Sekyrer E, Amansie E, Amansie W, Adansi E, Ahafo Ano S, Ahafo Ano N, Bosomtwi Atwima Kwawoma)

pH –Acidic (pH <6.5)	Iron Content (WHO: 0.3 mg l^{-1})	Coliforms (WHO: 0)	Total Dissolved Solids: (WHO: 1000 mg l^{-1})	'Potable & wholesome water'
39.8%	7.5%	62.4%	1.1%	24.7%

Figure 5.9.4: Planning layouts in the Kumasi peri-urban area

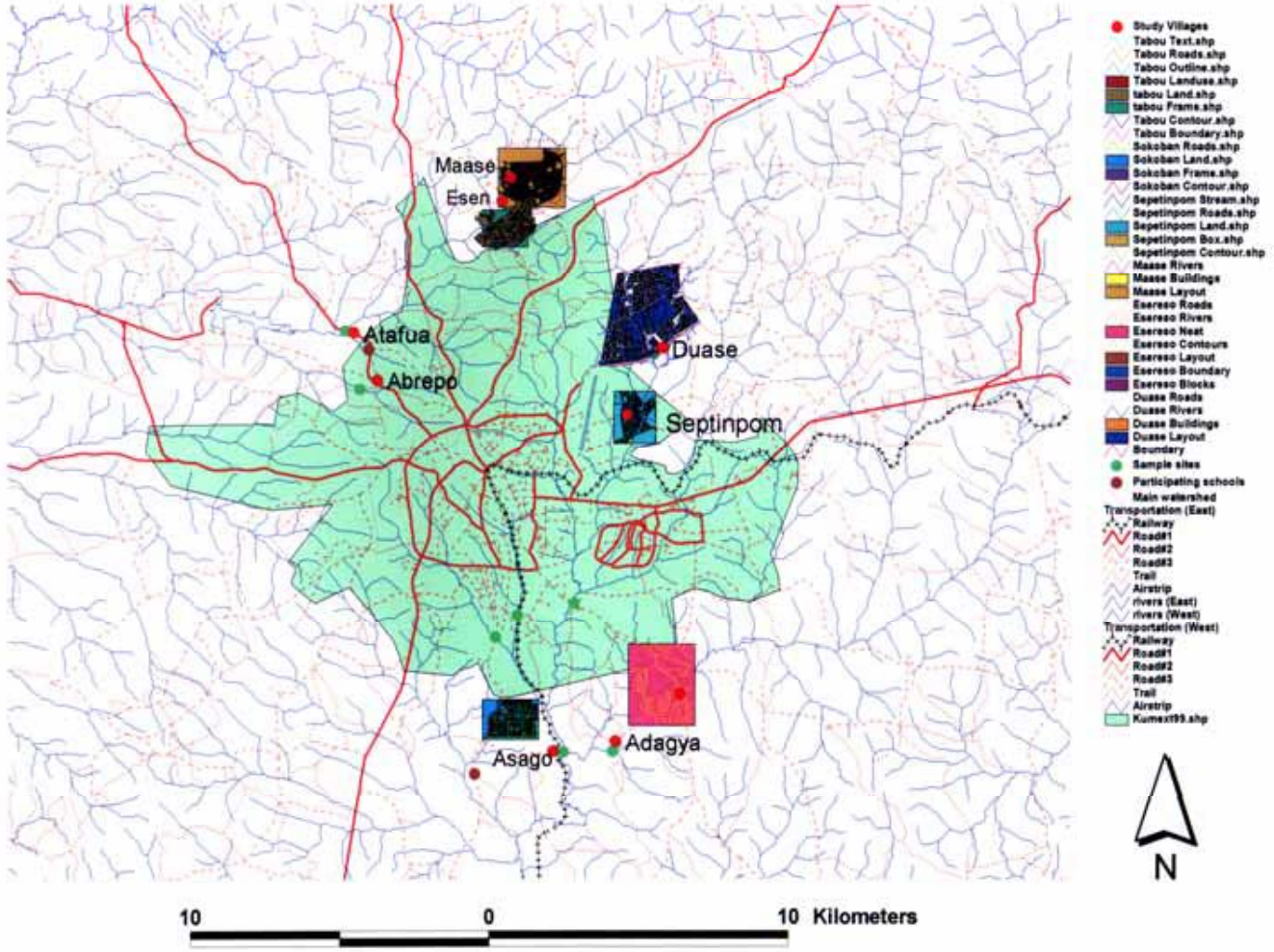


Figure 5.9.5: Planning Layouts north and east of Kumasi centre

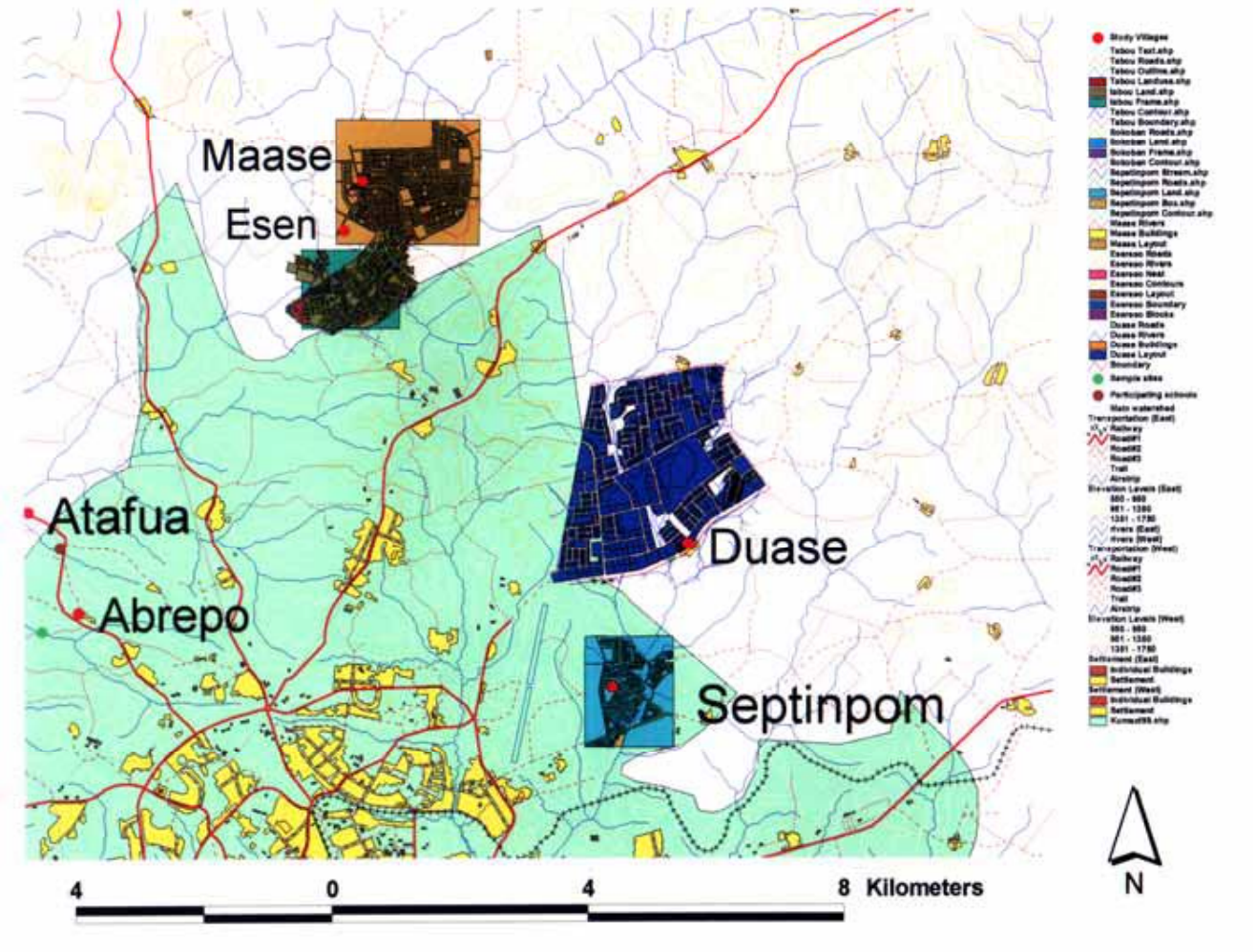
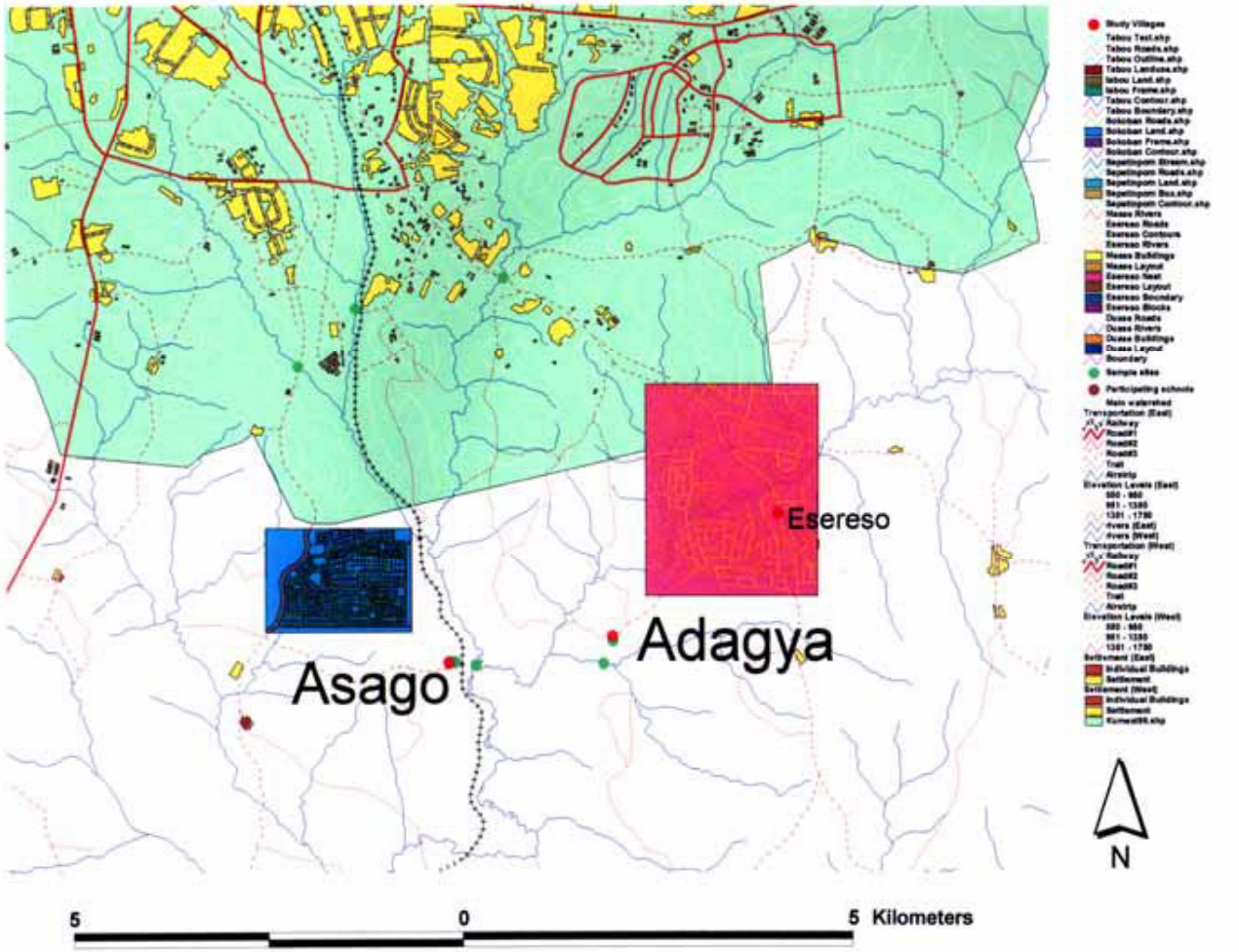


Figure 5.9.6: Planning layouts south of Kumasi centre



Sampling of a borehole at Adagya and a hand-dug well at Asago by this Project also shows significant coliform contamination. It is difficult to determine the source of such contamination. It could come from those who maintain the facilities or extract water, *an external source of contamination to an otherwise potable supply,* or it could be that the aquifer itself is becoming contaminated. Soil seepage should filter out most pathogens, but these data, when taken in combination with the CWSA survey of water quality (Anon, 1998) (Table 5.9.1), suggests widespread contamination (at least of the relatively shallow hand-dug wells).

Water Balance

Rapid peri-urban expansion and the associated increased demand for groundwater will eventually put severe pressure on the extent to which recharge rates can match human demand. The result could be falling groundwater tables and the reduction of well and borehole yields.

Calculation of the water balance gives some idea of the supply status for the area although there is a lack of data for some key stores and fluxes which make a detailed water balance impossible. However, using a mixture of secondary data sources and Duah *et al.* (1995) the basic elements of the water balance can be estimated.

Table 5.9.2: Water Balance Information

Mean Annual Precipitation (1961-1998) – Kumasi Airport:	1373.5mm
Potential Evaporation rate (mm) Akim-Oda Basin (Min Works & Housing)	1334.0 mm
Mean Runoff (1978-1985) Akim-Oda Basin (Min Works & Housing)	355.2 mm
Recharge (Min Works & Housing)	276.0mm

In the absence of actual evaporation data, soil water storage or more reliable river flow data, making any conclusions regarding the water balance must be regarded as, at best, provisional. The data in Table 5.9.2 come mainly from the Ministry of Works and Housing 'Building Blocks' study (1998). No basis is given in that report for the derivation of the mean runoff or recharge figures.

For the purpose of this discussion the following water balance equation is used:

$P - E = R + Sw + Rc$ **Equation 1**

where P = precipitation, E = actual evaporation, R = surface runoff, Sw = soil water storage, Rc = recharge to groundwater.

It is clear that the balance does not work if the calculated potential evaporation rates are used. The other data provided by the 'Building Block' study, along with the 30-year average Kumasi rainfall data, suggests that the water balance is:

$1373.5 - E = 276 + Sw + 355.2$

$E+Sw = 742.3mm$

A more important issue is the extent to which increased population, housing and well/borehole density will affect the net recharge rates of the aquifers. No general solution can be given due to the anisotropy of the aquifer systems but an order of magnitude calculation can be given for the layout plan areas.

The area of the layout in Figure 5.9.7 is $2.275km^2$ and it contains about 799 plots for housing. Many of the plots are already occupied and building has begun. The density of housing plots is $351/km^2$. Assuming an average of 5 persons per plot and a conservative estimate of water use of 30 litres/day/person (Engmann, 1993) we can estimate the water use for an individual plot for a year. Each household will use about 150 l/day ($0.15m^3$/day). This amounts to $54.75m^3$/year/plot.

Over the layout (with 799 plots), and making the conservative estimate that all of these plots will be taken up by private housing or similar usage, the total water use on this basis over one year would be $43,745.25m^3$/year. This is equivalent to $19228.7m^3/km^2$/year, or 19.2287mm/year over the whole layout.

Comparing this rounded up water use figure of 19.23mm with the 'Building Blocks' annual recharge figure of 276mm, it would appear at first sight that there is little current threat to the recharge of groundwater resources. However, it is important to note that, as discussed above, aquifers are extremely localised and uneven in their occurrence and productivity and local difficulties might arise.

The estimate of water use per person of 30 litres per day is based on Engmann's (1993) suggested value for rural inhabitants. Assuming that peri-urban dwellers use more water, say an average of 50 litres/day/head, this leads to an estimate of 91.25m^3 per year water use by each 5 person household. At the layout scale, with 799 plots, this gives a conservative water use/layout/year of 72,908.75m^3/year. This is equivalent to 32,047.8m^3/km^2/year for the plot. In water equivalent terms this is 32.05mm/year over the layout.

Table 5.9.3: Weighting of recharge rates by the average monthly rainfall totals

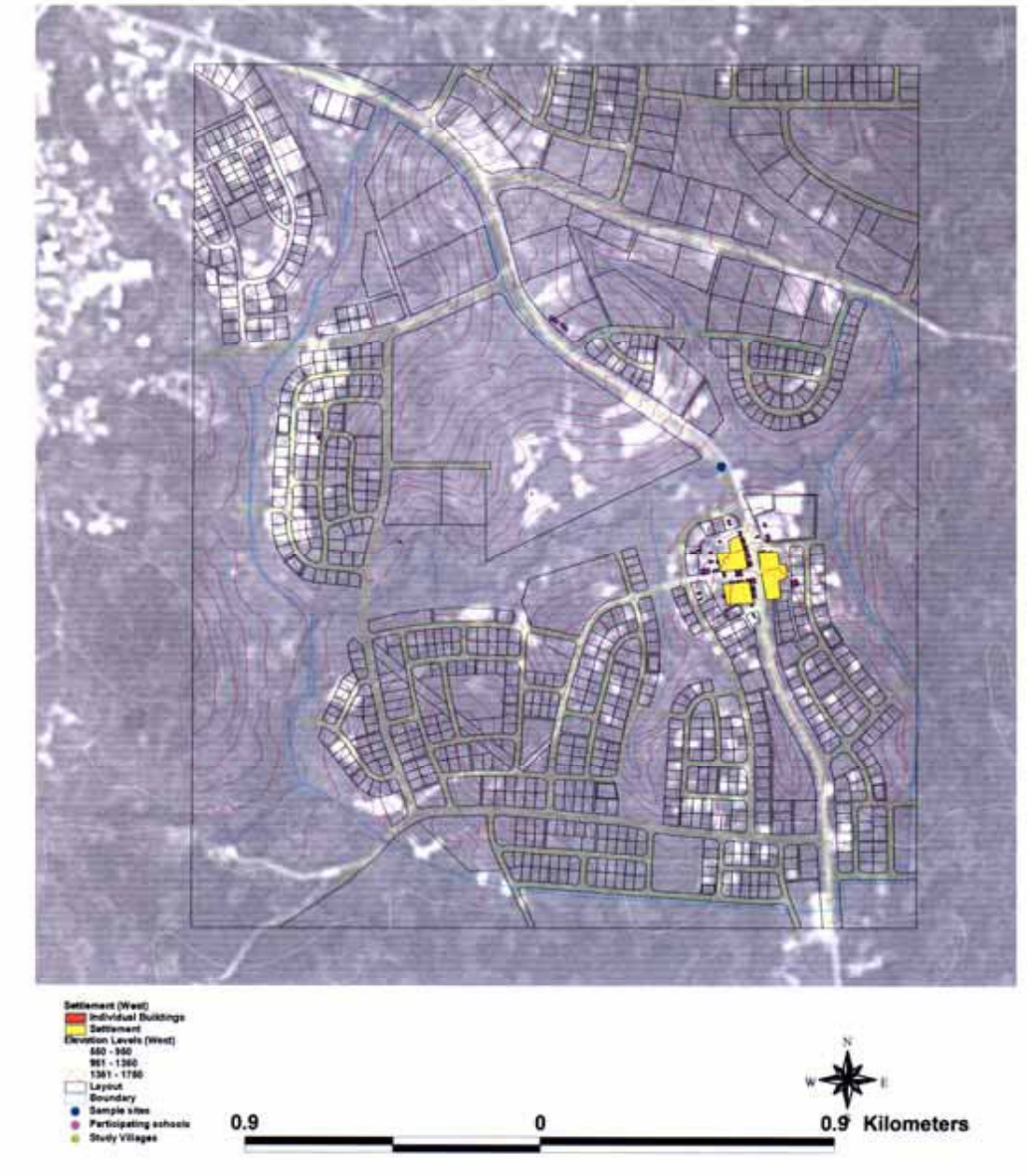
Month	Rainfall (mm) Monthly average	Rainfall –Proportion of total	Weighted Recharge mm
January	16.9	0.0123	3.395
February	60.0	0.044	12.14
March	125.6	0.0915	25.25
April	141.7	0.103	28.43
May	178	0.13	35.88
June	207.6	0.151	41.68
July	144.4	0.105	28.98
August	88.3	0.064	17.66
September	162.4	0.118	32.57
October	149.4	0.109	30.08
November	66.5	0.048	13.25
December	26.7	0.0195	5.38

On a monthly basis this higher estimate of human water demand is 2.67mm per month over the plot. Monthly recharge has been crudely estimated (Table 5.9.3) by weighting the total annual recharge figure by the monthly rainfall totals. Although this neglects equivalent effects on soil water storage, evaporation and surface runoff, it does allow some comparison of likely water use and recharge at a higher temporal resolution. Even under this conservative assumption, at the layout scale, increased water demand should not at present lead to severe stress on the groundwater resource.

It should be remembered, however, that there are a number of conservative estimates in these calculations. For example, the 30-year rainfall mean of 1373.5mm has been used, rather than the mean over the last decade of around 1250mm, itself indicating a clearly declining trend. Further, the assumption that all plots will be taken up by private housing is undoubtedly conservative. In short, the key message for stakeholders, at all levels, is that the continuing availability of uncontaminated groundwater resources is not a sound assumption. Until significant research has been carried out into the nature and scale of aquifer configuration in peri-urban Kumasi, it can not be assumed that groundwater resources can be tapped on an unlimited basis without hindrance. Current rates of abstraction are not problematic, but projected usage could be.

In terms of river and stream water, a clear message of ubiquitous contamination can be put forward. Much of this contamination – which increases as water flows through both the urban and peri-urban areas - arises from reasonably easily identifiable sources, but can only be addressed successfully by a concerted effort by all stakeholders.

Figure 5.9.7 Esereso - Layout with 1995 Spot Imagery



5.9.3 Borehole Data

Borehole logs were collected from several sources including Geotechnic Ltd and the CWSA. However, the coverage precluded detailed water table modelling due to the poor resolution of the borehole coverage. To carry out detailed dynamic modelling would require a much denser mesh of borehole information. This is particularly necessary given the geological conditions described above, which give rise to localised aquifers.
Figure 5.9.8, from KUMINFO, shows the location and depth of water table at those boreholes for which such information was available. Arc View Spatial Analyst in KUMINFO was deployed to produce a crude groundwater table surface for the area based on the boreholes in Figure 5.9.8.

Figure 5.9.9 shows the resulting surface. Theoretically, it is possible to define the groundwater flow paths, and hence likely groundwater pollution paths from source areas, as flow can be assumed to occur perpendicular to the groundwater table contours. Note that the broad flow field would be from the light (NE) to the darker (SW) areas.

Figure 5.9.8: Location of wells for which water table depth is available

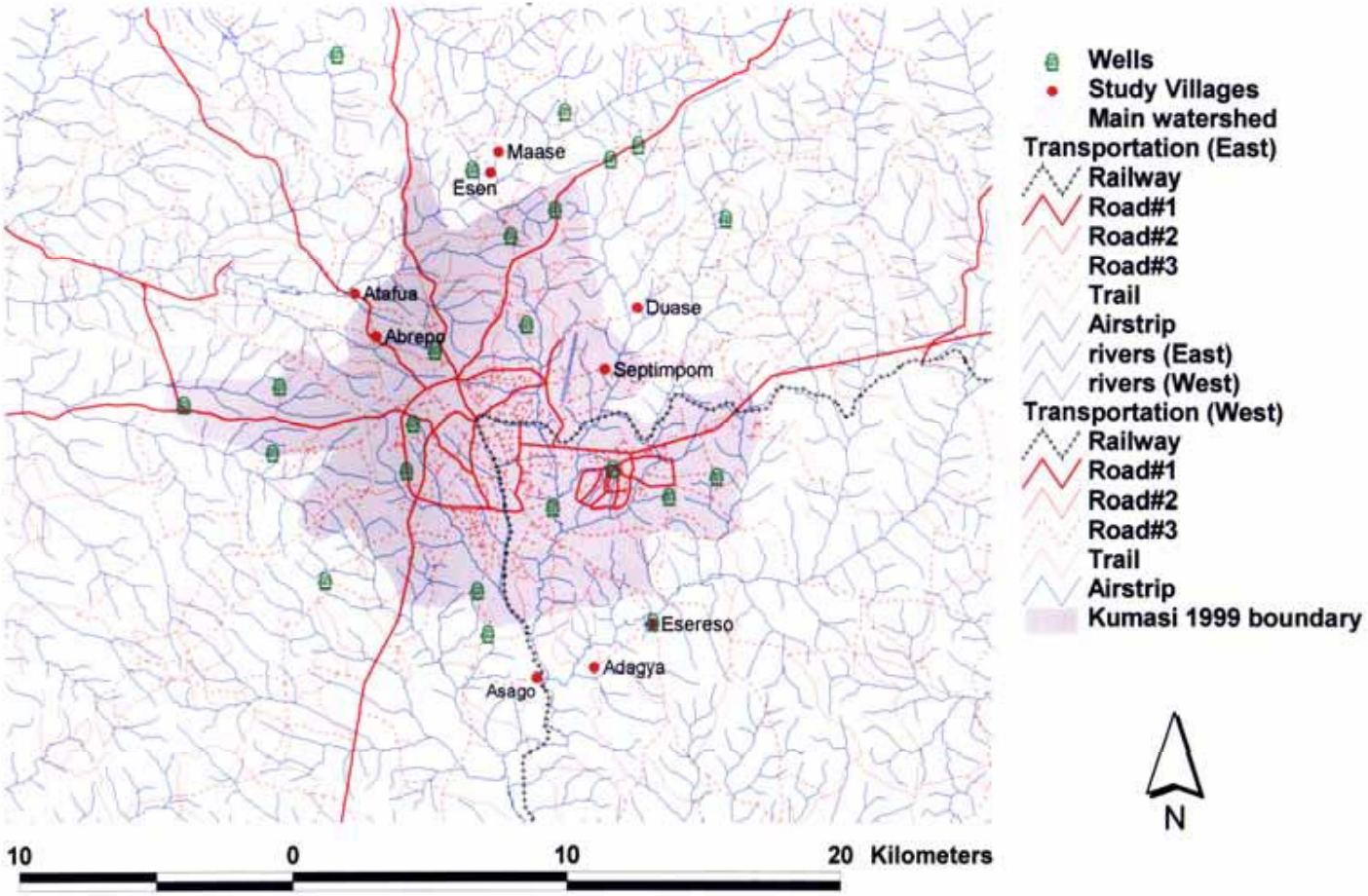
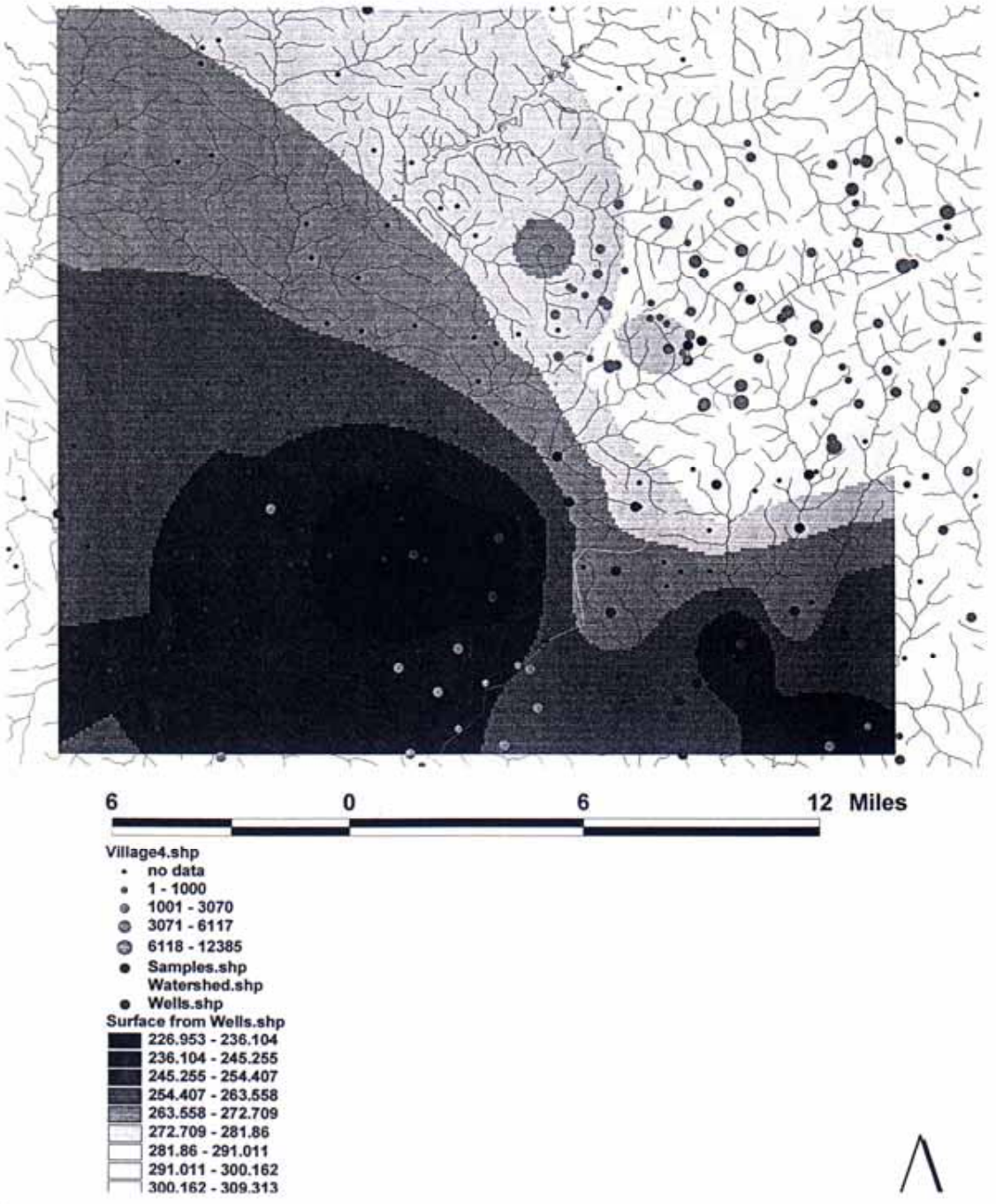


Figure 5.9.9: Water table height in the Kumasi region. Surface derived using 3-D Analyst in ArcView. Darker shading indicates lower water tables.



This approach requires a greater density of groundwater information to be taken any further forward, however.

The Watershed Management Framework (WMF) [2F]

This Section presents the Watershed Management Framework (WMF) – a major Project output **[Output 2F**]. It is a 'stand-alone' document for use by stakeholders and within the communities, and is presented here as a separate entity. It should be considered in conjunction with the handbook tailored as a more pictorial reference guide to watershed protection for use within the communities (Appendix D). A further relevant document which is designed to be consulted in parallel with the WMF is the *Directory of Development and Environmental Organisations and Institutions Operating in and around Kuma*si (Appendix G). This *Directory* is available in hard copy form, and is also held by, and is designed to be regularly updated by, the KUMINFO laboratory at IRNR, KNUST.

The WMF comprises six sections.

Section 1 introduces the background to the Project, the rationale behind the WMF and how it is proposed it be used by stakeholders.

Section 2 details the structure and elements of the WMF – what these are, and why they are considered to be important

Section 3 presents the practical problems faced by communities in respect of water resource use and environmental protection of the watershed. Possible low-cost or no-cost solutions to those problems are suggested.

Section 4 sets out 'best practice' guidance notes to help communities and individuals mobilise themselves and their corporate human resources in pursuit of better environmental management. This section includes practical advice on how to go about seeking funding for community microprojects.

Section 5 outlines the most likely and important roles of each of the stakeholder groups in the pursuit of better environmental management.

Section 6 gives guidelines to assist community fundraising for microprojects. The *Directory* introduced above is designed to assist in the identification of appropriate contacts for guidance or assistance in this respect.

Section 7 outlines the role of the KUMINFO Geographical Information System held at IRNR, KNUST. It gives brief details of the potential of the system for assisting in environmental decision-making. Contact details of key personnel are given.

Figure 2.1 is adapted from: Newson, M. (1994) Hydrology and the River Environment: Oxford: Oxford University Press

Figures 3.2, 3.3 and 3.4 are adapted from Morgan, R.P.C. (1995) Soil Erosion and Conservation Harlow, U.K.: Longman.

The agroforestry diagrams were kindly provided by Dr James Quashie-Sam, IRNR, KNUST

Centre for Developing Areas Research (CEDAR)
&
Institute for Renewable Natural Resources (IRNR)

WATERSHED MANAGEMENT FRAMEWORK

November 2002

DFID Natural Resources Systems Programme

IRNR

CEDAR

Watershed Management Framework (WMF)

For

Communities and Stakeholders in Peri-Urban Kumasi

This document is an output from a project funded by the UK Department for International Development (DFID) for the benefit of developing countries. The views expressed are not necessarily those of DFID.

INTRODUCTION

A multidisciplinary team of UK and Ghanaian researchers has been collaborating towards the formulation of a framework for sustainable, equitable watershed management in peri-urban Kumasi. The Project has investigated the institutional, socio-economic and physical factors affecting the groundwater and surface hydrology. The focus is on interactions between water resources and changes in land use due to urbanisation in two watershed areas, including analysis of the quantity and quality of water resources and their access, management and control.

This work has been funded by the UK Department for International development (DFID), Project R7330: Peri-Urban Natural Resource Management at the Watershed Scale, Kumasi, Ghana.

The principal goal of the Project is to contribute towards the optimal management of peri-urban resources through improved productivity and resource use efficiency, and thus to contribute towards the alleviation of poverty. In particular, the impacts of urban growth on land use patterns and natural resources degradation will be identified and incorporated into strategies for peri-urban planning and management.

The Project has adopted an interdisciplinary approach, with principal methodological focus on:

- characterisation of the physical environment
- characterisation of land use and the causes of pollution/degradation in selected representative watersheds
- characterisation of water resources and their use
- characterisation of the socio-economic environment
- development of Geographical Information System (GIS) outputs for watershed management

The latter stages of this research project were devoted to the development, implementation and testing of a participatory framework for sustainable co-management of the environment and natural resources at the watershed scale in two study catchments or sub-catchments. Co-management is the joint and participatory management of a resource, facility or particular area by all the relevant stakeholders; but especially those who live on/at and use the resource, land or facility

This is referred to as the *Watershed Management Framework (WMF)*. However, it is probably more appropriate to think of it as a framework or set of mechanisms than a plan, which has rather formalistic and static connotations.

This introductory section explains the objectives, basic principles and definitions within the WMF. The following sections provide

- an outline of the different structures, mechanisms, procedures and activities envisaged;
- an overview of the roles and responsibilities of each level of stakeholder;
- simple, low-cost or no-cost guidelines on how to conserve and protect the natural resources in the catchment.

Poverty reduction focus

In terms of DFID's mission and guidelines, we were required to focus our project activities on poverty reduction. What does this mean for our community mobilisation, participatory and sustainability activities?

- Simply to assert that any development work in predominantly poor villages/communities is fulfilling this mission is inadequate, as it may help only a minority, or those who are already better off, and could increase differentiation and exacerbate the situation of the poorest. This would hardly constitute empowerment.

- Hence, it is important to ensure that key sub-groups of each village population are consulted as to their problems and priorities (which we have done extensively through different mechanisms), and are then represented on any committees (e.g. UC, WATSAN or project-specific group) that may be established. Particular attention must be devoted to ensuring that the weakest, poorest or most marginalised (often women, female household heads, the elderly, ethnic/religious minorities) are represented approximately proportionately. This may take considerable time, sensitivity and perseverence to attain, but such inclusiveness is likely to be crucial to the longer term sustainability.

- Even so, representation on a committee or workparty is no guarantee that everyone's interests will be assured. Community leaders and facilitators, and any professionals involved in co-management initiatives, will need to monitor the situation and provide skills training ('capacity building') as necessary to enable the marginalised to participate meaningfully and thereby to empower themselves.

- Many poverty reduction activities, including rotating credit schemes, actually fail to address the needs of the poorest of the poor. Sometimes this is by default (because of a failure to appreciate the different degrees of poverty, or because of the unaffordability of the interventions) but sometimes deliberate (e.g. where a particular level of assets or income is required for eligibility so as to ensure repayments).

- In this community work, it is important to ensure that the poorest members are not
    - excluded; or
    - disadvantaged e.g. by having to remain dependent on poorer quality water or a more distant source of supply; or having their land lost to a village project;

  and that their priorities are adequately represented in the action plans, project proposals and implementation processes arising from these activities.

1.1 Purpose of the Watershed Management Framework (WMF)

The basic purpose of the WMF is to ensure better watershed management by involving all stakeholders in a structured approach to the protection of the local environment in general, and its land and water resources in particular.

1.1.1 Why is it necessary for all stakeholders to be involved*?*

Imagine that the stakeholders are in effect a team. That team is only as strong as its weakest link. If one major stakeholder or group of stakeholders refuses or fails to collaborate in the management process, it becomes much more difficult for the remaining stakeholders to implement it successfully. Thus, all stakeholders need to be involved in the setting up of a comprehensive management process and plan, and each stakeholder or group of stakeholders has a role in ensuring its smooth running.

Each stakeholder or group of stakeholders will have different priorities (for example, the protection of agricultural land for the farmer; protection of unpolluted water supply for the villagers), and these priorities have to be recognised and balanced against the necessity to use resources to provide sustenance or income (for example, the use of water for irrigation or for cooling machinery).

1.1.2 Why use the catchment as the process/plan unit?

Behind this approach is the logic of using the natural hydrological and other flows from the top to the bottom of the catchment as a driving mechanism. The catchment as a unit comprises the separate drainage units in the landscape – the *watersheds* and *(sub-) catchments* of individual streams or rivers from the smallest tributary to the major river. In virtually all cases, catchments and their watersheds cross political and administrative boundaries. Instead, the focus is on the movement of water and solid and dissolved materials through the catchment, in other words, between the watersheds that delimit the top and sides of the catchment. The bottom of a catchment is usually where a river enters the sea or a natural inland water body with no further outflow[1].

However, for local scale research and policy such as was undertaken during this Project, a subcatchment is the relevant unit of analysis, and this ends where the stream or river enters a larger river or a water body, e.g. the Owabi Dam. In pragmatic terms, a subcatchment may also be thought of as ending where the river leaves the Project area, e.g. there was no direct concern in this Project with the Sisa/Oda system all the way to its ultimate destination. Nevertheless, if such a cut-off is adopted for pragmatic reasons, it is vital to bear in mind the possible downstream impacts (*beyond* the Project area) of activities and interventions *within* the Project area. The same applies to impacts within the study area of upstream activities if the top of the catchment lies outside the area of concern. This principle is central to the watershed or catchment approach.

A catchment or subcatchment approach can therefore act as a means to identify different attitudes and practices with respect to environmental conservation by stakeholders concerned with the use or management of different parts of the area (for example, different Unit or Area Committees, District authorities, or a District Assembly and Kumasi Metropolitan Assembly), and of proposing a framework of action to even these out in a positive way.

Importantly, this approach can also be implemented in a flexible way at different scales, by taking individual catchments or subcatchments of different sizes, and applying similar principles to their management. It can therefore be applied to a range of peri-urban (and indeed urban and rural) environments, to ensure that appropriate environmental safeguards are applied to their differing physical characteristics and existing and proposed resource uses. Environmental resources are understood here in a broad sense, including land, air and both surface water and groundwater.

1.2 Structure and Operation of the WMF

The WMF comprises a logical framework of mechanisms and activities at different scales within the catchment designed to achieve the objective stated above. These are:

- the whole catchment or sub-catchment
- individual villages or communities within the (sub-)catchment
- microprojects and other activities within villages which serve as catalysts for collaborative organisation, action and maintenance

Although distinct, these nested elements should be interdependent in a well functioning framework. *The different scales of mechanism and activity should not be thought of as hierarchical in a top-down sense. Co-responsibility and joint management will be important in all of them, although the precise set of partners and partnership relationships will vary*. As a generalisation, the roles of professionals and officials are likely to be more pronounced at the strategic level of the (sub-)catchment, where liaison and integration across several communities is necessary. However, villagers and their representatives must be – *and must feel themselves to be* – central participants in decision-making and in control of the outcomes. This is the concept now often referred to as 'ownership' in development terminology.

1.2.1 How is the WMF managed at the community level?

At the community level, the WMF is intended to be managed through a spirit of participation and community ownership of the process in order to maximise its chances of sustainability. *The underlying*

[1] A note on terminology: 'watershed' and 'catchment' are often used interchangeably; however, we distinguish them here in the manner just described, in other words the watersheds are the boundaries of catchments.

principle should be the co-management of the environment and environmental resources with the relevant institutional stakeholders. It will require responsible individuals or committees to initiate and to drive the WMF forward within the community. In communities where Community Level Facilitators have been appointed, then these may be willing to assume a lead role, with community agrremewnt.

However, based on experience with community-based programmes in different countries*, the guiding principle in this respect must be to minimise the additional burden of new committee structures on the community. In other words, wherever possible, the relevant responsibilities should be given to appropriate committees that already exist and function reasonably well.* The most likely candidates will usually be the Unit Committee and/or WATSAN Committee. The precise outcome will reflect the situation in each village and the focus of planned WMF activities there. In some cases, a joint subcommittee of both committees might be appropriate.

Only in cases where there is no effective committee structure, or conflicts within the community preclude effective operation of relevant committees and appropriate liaison between them and their traditional leaders and/or assembly representative, is it likely to be appropriate to establish a new committee with a specific brief to implement the WMF. In all participating villages, it would be sensible to try to establish a WATSAN or Unit Committee if no functioning one exists. This would help the community's institutional development in broader terms than simply this project and the WMF, by facilitating liaison with relevant local institutions and integrating the village within statutory structures, and thus enhancing the prospects of sustaining the WMF for the future.

Successful operation of the WMF will require one or two person(s) on the (sub)committee to assume ultimate responsibility for the process. The person(s) should have relevant skills, experience, interest and time, and thus not necessarily be the chair and/or secretary of the committee. The person(s) will act as 'Environment Officer(s)' (or other suitable job title) for the community.

1.2.2 Key tasks for the Environment Officer(s) will be:

- to record environmental problems or concerns as they occur, in an appropriate logbook;
- to facilitate discussion of these by the committee implementing the WMF and with the wider community as appropriate, and to record these discussions and their outcomes;
- to ascertain and co-ordinate with the most appropriate person (e.g. chief, queenmother, UC or WATSAN chair) to take concerns to the institutional level as promptly as possible. The 'Environmental Officer(s)' may also be the appropriate person(s);
- to log such actions and the official responses;
- to liaise with the institutions and relevant villagers/committees to ensure the timely undertaking and completion of any necessary remedial action.

1.2.3 How is the WMF managed at the institutional level?

At the strategic level, an overview of the progress and relative efficiency of individual Community WMFs is required. Clear lines of communication must be established between the communities and higher-level institutions, such as Area Committee, District Assembly or KMA. There should be careful consideration of whether existing channels of communication are adequate and effective, or whether an appropriate (and specifically designated) officer in each of these bodies should be assigned to act as liaison person with the communities over WMF issues. Either way, a record of concerns raised by communities and the action taken would need to be kept by the respective bodies.

The overview of WMF activities, and the degree to which the process is working to the benefit of all stakeholders requires careful monitoring. This needs if at all possible to be undertaken by an agency which is seen to be both supportive of the general process, and impartial in assessing its degree of efficiency. This points to the involvement of an impartial NGO, such as CEDEP, as the 'watchdog'. The involvement of the Regional Office of EPA in respect of environmental matters is seen as highly desirable, though it is recognised that there is potential for conflict with polluting stakeholders.

1.3 The Stakeholders Involved

In the WMF, every individual or group of individuals with a direct or indirect interest or who will be affected by it, is a stakeholder. It is vitally important that all stakeholders participate freely and equitably

in planning and decision-making, and that the lines of communication are clearly drawn and open, so that their effectiveness can be tested.

As already explained in Section 1.1 above, success will be far more difficult to achieve if one or more stakeholders fails to participate. This applies as much to those with a formal or statutory responsibility as to those participating voluntarily. If the WMF works effectively, all parties stand to benefit. Conversely, defaulters may potentially cause disbenefits for all other stakeholders. Voluntary participation is far better than compulsion, because goodwill and commitment can not be created artificially.

1.3.1 Most Likely Stakeholders

Community: The Community at large
Chief and Elders
Unit Committee
WATSAN Committee
Community Level Facilitators (if present)
Teachers
Schoolchildren/parent-teachers' association
Churches within individual communities.
Occupational groups (eg sandwinners)

Assemblyman/woman

Polluters (other than 'normal' village/domestic activity)

Town/Area Council

District Assembly/Kumasi Metropolitan Authority:
District Environmental Management Committees

Regional Co-ordinating Council:
Relevant regional offices of line ministries

Others: Governmental organisations or equivalent:

- GWC
- CWSA
- EPA
- SRI

University Research Institutes

NGOs:

- CEDEP
- GOAN
- TREND
- ISODEC
- Friends of Rivers and Water Bodies
- Church Organisations
- Women's Associations and other groups

The roles and responsibilities of stakeholders will be detailed in Sections 4 and 5.
It must be stressed that willing collaboration is better than compulsion!

STRUCTURE AND ELEMENTS OF THE WMF

2.1 Introduction: Structure of the WMF

This section introduces the major elements considered in the WMF, and examines briefly why these are important.

To start with, the three levels or scales of activity listed in Section 1 will be elaborated on. The major elements below cross-cut this scheme in as much as they do not fit neatly or entirely within any one of those scales. Rather, there will need to be collaborative actions linking village committees, entire communities and the institutions concerned with the (sub-)catchment in order to address them appropriately. The precise balance of inputs from the different stakeholders will vary according to specific circumstances.

2.1.1 The Catchment or Sub-catchment Scale

This is the 'strategic' scale within WMF, at which the hydrological flows, geomorphological structures, soil conditions, and larger scale human activities that affect several villages are studied. As explained in Section 1, the boundaries of a catchment are delineated by the watersheds; accordingly, this is certainly the most appropriate scale at which to address hydrological flows. Some large-scale human activities actually transcend individual catchments and sub-catchments, but those like dams, irrigation schemes, sewage treatment works or even discharges of industrial effluent - that affect water volumes, qualities and flows – are very important at this scale.

Precisely because the relevant structures, flows and activities are beyond the confines and control of individual villages or communities, co-ordination, planning and liaison are necessary. These functions are more specialised and generally require substantial inputs from professional institutional staff. Partly for this reason, the KUMINFO Geographical Information /system (GIS) held at the Institute of Renewable Natural Resources (KNUST) can be deployed very fruitfully at this scale, both as a database and as a tool for predictive modelling of the likely impacts of future developments.

However, it must be reiterated that community participation and consultation are no less important merely because several villages are involved. Area Committees and District Assemblies/Metropolitan Assemblies are the levels of representative structures above the Unit Committees of individual villages, and they therefore have important roles here, despite the fact that their boundaries will seldom coincide with those of (sub-) catchments.

2.1.2 The Village Level

Here concern is with the individual village and its lands. Considerable diversity of conditions exists within peri-urban Kumasi and even the eight villages in which this Project worked. In Abrepo and Sepetinpom, urbanisation is far advanced, and agriculture and other traditional rural landuses are now vestigial. Esereso is experiencing rapid housing construction, and the recent resolution of a longstanding land dispute in Duase may have the same consequences there, given its proximity to the expanding built-up area of Kumasi. The others are experiencing less intense pressures from urbanisation, but even so, inmigration of people, rising land prices, sandwinning, river pollution and other activities are in evidence to differing extents. In parts of these villages' lands, agriculture is intensifying with the use of artificial fertilisers and pesticides.

At this level, small-scale variations in hydrological and soil conditions can still be important in terms of agricultural potential, the feasibility of providing irrigation, appropriate locations for new wells or boreholes, and so forth. Sufficiently detailed data are contained in KUMINFO to make it useful for such applications too, along with other specialist professional inputs. Landuse changes and their impact, or, conversely, undertaking sensitivity analyses to determine the most appropriate sites for new housing developments and so forth, are particular examples.

Institutionally, the most important committees at this scale are those which represent the village, namely the Unit Committee and WATSAN. There may also be other relevant committees in existence for specific purposes, e.g. health and women's affairs. Unit Committees are a recent innovation as part of the government's decentralisation programme, and most were inaugurated during the second half of 1998. WATSANs also should now exist in all villages, but they were found to be non-functional in some of the Project's study villages. As explained in Section 1, assistance with the establishment or (re)invigoration

of such committees is likely to be preferable in terms of official recognition and longer term sustainability than seeking to establish a separate new committee to implement the WMF.

Such committees should be fully representative of the village communities concerned. In certain cases, this is questionable on the basis of the age, gender, political affiliation or ethnic membership of the committees. In particular, women, the youth, disabled people and migrants (especially if living in a separate zongo) are commonly excluded or not represented. The WMF's prospects for success will be greatly enhanced if such deficiencies can be addressed, but this may be very sensitive.

2.1.3 Microprojects and Other Activities Within Villages

We have provisionally distinguished this as a third scale because some of the individual activities or projects to be undertaken as part of the WMF may affect, or be implemented by, only a small part of the community. Under such circumstances, direct responsibility for them may rest with the villagers concerned or with a sub-committee of the relevant village committee. The range of possible microprojects is large (see 2.1.3.1), but the rankings of problems and priorities for addressing them expressed by the villagers during extensive participatory consultation/appraisal process, suggests the interventions and activities listed in Table 2.1 as those most likely to be of benefit in the early stages of activity.

Importantly, however, the objective of the WMF is not simply the completion of a particular construction activity or intervention, but to do so in a gender-aware and environmentally-sensitive way, together with ongoing care and maintenance of that facility as part of a sustainable, co-management effort. These considerations underline the necessity for effective linkages to the village and in some cases also the catchment scales.

A survey of village priorities for micro-projects has been undertaken (see Table 1). It must be noted that these were the priorities identified by these particular communities at the time of survey. Priorities will vary between communities, and will also vary over time within one community.

2.1.4 Provisional List of possible micro-projects

There is a wide range of types of micro-projects that communities can undertake to protect and improve their immediate environment. Though some of these require funding which may be beyond the resources of the community, many possible micro-projects are low-cost or even no-cost options. Where resources beyond the community would be necessary, external sources of support may be approached. Section 6 of this document provides guidelines on how to undertake fundraising.

Possible projects include:

- borehole
- hand-dug well
- river bank/floodplain protection
- waste disposal/garbage: sorting/recycling/composting
- VIPs or similar latrine systems:
    - siting?
    - protection
    - biogas latrines
- protection against soil erosion
- use of vegetation in protection and in screening garbage dumps/latrines
- school/community hall facilities
- rainwater harvesting systems
- monitoring of Kaase temporary sewage site, and other KMA waste and refuse dumps
- monitoring of range of fish species and number/size/condition caught by fishermen, at Asago.
- monitoring of environmental issues on agendas of DAs, KMA, RCC, etc by assemblymen/women, Unit Committee chairs and other representatives.
- site rehabilitation/reclamation:
    - sand winning sites
    - marsh sites
    - sites of organic pollution
    - sites of inorganic pollution
    - sites of erosion/topsoil removal

Table 2.1 Matrix of locally perceived village problems and possible priority actions, 1999/2000

Village	Inadequate potable water		Inadequate toilets and sanitation		Poorly sited or maintained waste dump		Soil erosion in village		Sand/gravel winning pits		Institutional/committee weaknesses		Water course encroached/ polluted
	Serious Problem	Action Planned	Serious Problem	Action Planned	Serious Problem	Action Planned	Serious Problem	Action Planned	Serious Problem	Action Planned	Serious Problem	Action Planned	Serious Problem
Maase	Moderate √	Hand dug well							√√	Rehab = vegetation + OF			√
Sepe tinpom			Especially in Zongo	Maybe new KVIPs	Especially in Zongo	Tackle littering							√
Duase	Irregular pipe flow	Discuss with GWC; pass hand dug well		Assist completion of new KVIP if still pending	√	Tackle KMA		Tackle gullying + sheet erosion					
Adagya								Tackle gullying + sheet erosion	√√	Tackle: finish rehabilitation + veg + OF		Liaise locally; Help establish WATSAN	√
Atafua							√√		√√	Rehabilitation = Vegetation + OF		Try to involve assemblyman	√
Abrepo			√√	Improve maintenance or relocate	√√	Improve clearance and maintenance or relocate		Tackle erosion + drainage				Try to reconcile chief with UC + assemblyman	√
Asago	√√	Borehole (co-funded)						Tackle erosion + drainage					√√
Esereso					√√Too close to river and houses	Relocate dump			√√	Rehabilitation + OF if not to be used for housing			√

Key

OF = organic mulching and planting methods other villages

NB: micro-enterprise tree nursery in Esereso needs markets: we should buy saplings/seedlings there for planting in

2.2 Land Use Criteria

A basic understanding of the criteria applied by landowners when land is developed is essential to managing the process of land use conversion from forestry and agriculture. Unfortunately, the pressures on the peri-urban zone are such as to progressively diminish the availability of land for agriculture, as there is relatively little accessible forest land left in the area around Kumasi. The main development control mechanism is the preparation of a layout plan for each village or community area. Plots are then allocated to specific uses, and are made available for sale where appropriate.

2.2.1 Who is involved in land management in Ashanti?

Land management in Ashanti has traditionally been the prerogative of traditional authorities. This is done through a hierarchy of traditional rulers as follows:

- The Golden Stool

The *Asantehene*, who is the occupant of the Golden Stool, holds all lands of the Ashantis in trust for the people. By tradition and in principle, the *Asantehene* protects and manages all lands for the general good of the people. He is aided in his traditional role of land management by a number of paramount, divisional and sub-chiefs/*Odikros* (regents) who represent him in various traditional areas, towns and villages in Ashanti.

- The *Omanhene*

The *Omanhene* is the head of the divisional and sub-chiefs in his traditional area. He has jurisdiction over lands in his traditional area and is answerable to the *Asantehene*. He has power to lease lands for development in any part of his traditional area in consultation with the divisional and sub-chiefs concerned.

- The Chief/*Odikro*

The Chief/*Odikro* represents the *Omanhene* in towns and villages within a traditional area. Usually the Chief/Odikro is the first contact person for the allocation of land. As a result most land negotiations are carried out between the Chief/*Odikro* and the prospective developer. The *Omanhene* normally signs the allocation paper although this duty is increasingly being performed in some towns and villages by the Chiefs/*Odikros*.

- Clans/Families

In some settlements, certain families and clans claim ownership to some parcels of land. The family head can therefore allocate some plots to perspective developers with the consent of the *Odikro* of the village who will either sign or send the allocation papers to the *Omanhene* of the area for his signature.

- **Individuals**

Non-subjects of stools or sub-stools may acquire the specific usufruct through contractual agreements with landholders, through payment of tribute, rent and other payment arrangements. Individuals who have acquired plots from the chiefs and have been given allocation papers may transfer ownership of their plot to a third party. Similarly, indigenes that have been allotted plots ether by the chief or the family head may dispose of them to prospective developers.

2.2.2 Who is involved in the preparation of layout plans?

The key players in the preparation of layout plans and their roles are as follows:

- The *Omanhene*

The *Omanhene* approves the zoning of an area under his jurisdiction and gives the chief/*odikro* responsible for the village or town the green light to undertake the zoning of the area. He may personally foot all or part of the bill for the preparation of the layout plan.

- The Chief/*Odikro*

The Chief/*Odikro* mobilises resources and organises his people in support of the preparation of the layout plan. He may personally foot all or part of the bill for the preparation of the layout plan.

- The District Assembly

The District Assembly has the statutory responsibility to undertake the preparation of layout plans for communities under their jurisdiction. Fees are charged for the preparation of plans for communities.

• The Survey Department

The Survey Department provides base maps, which give detailed information on the topography of the area targeted for zoning. This may include the interpretation of aerial photographs. The Department charges fees for its services.

2.2.3 What are the steps followed for the preparation of a layout plan?

A national policy enjoins all District Assemblies to prepare layout plans for all urban centres in the districts for which a revolving fund has been provided by the central government. The District Assemblies have legislative powers to make bylaws in respect of buildings, sanitation and the environment.

The initiative for the preparation of a layout plan may originate from the District Assembly or from the chief of the area.

- The Chief approaches the District Assembly (Town and Country Planning Office) when he decides to zone an area for development. Or District Assemblies make approaches and overtures to the chiefs for the preparation of a layout plan when a settlement is caught up with development
- The Planning Officer makes a reconnaissance visit to the site to be zoned to acquaint himself with the local situation and level of development in the area
- The planner makes follow-up visits to the community to collect relevant data for his work
- The Survey Department is approached for detailed information on the area to be zoned
- The Planning Officer makes sketches for discussion with the chief and the opinion leaders of the community for whom the plan is being prepared
- The final site plan is prepared for the area
- The chief and the office of the Town and Country Planning at the District Assembly keep a copy each of the layout plan.

2.2.4 What is included in the layout plan?

The District Planning Officer, as a matter of policy, holds discussions on the base map (which is authenticated by the Regional Surveyor) with the chiefs to explain to them the details of the topography of the area. The DPO details the natural reserve areas such as valleys, watercourses and steep slopes, stressing their importance to the ecology. The other important details taken into account in the preparation of the layout plan are as follows:

Residential plots

Residential plots are reserved for development into housing units and other social/recreational purposes

Industry plots

Industry plots are allotted for industrial development

Public Open Spaces

Cemetery and Sacred Groves
Children Play Grounds
Reserve Site
Public Utilities
Electricity Sub-Station
Refuse Dump

Civic and Cultural

Places of Worship
Post and Telecommunications
Clinic
Chief's Palace
Police Post
Fire Station
Hotel

Shopping Centre

Market
Lorry Park

Night Club
Corner Shop
Bank

Education

Primary and Junior Secondary Schools
Day Care Establishments

2.3 Land Allocation Procedures

The principal question here is: who is involved in land sales in towns and villages in Ashanti? The problems associated with land allocation procedures are dealt with later (Section 3.3).

Land sales and allocation vary from place to place and depend on local conditions. However the key players involved in land sales in Ashanti are as follows:

- The Chief
- The Land Allocation Committee
- Family Heads
- Indigenous Landowners

How then are plots acquired for development? The principal steps are as follows:

- A prospective developer approaches the Chief/*Odikro* or the Land Allocation Committee of the village and makes a request to acquire a plot of land for development. The developer makes his intentions clear as to whether the plot is needed for residential or industrial purposes
- The prospective developer is taken to the zoned area by the representative of the chief or the Land Allocation Committee to make his choice
- The Developer pays 'drinks money' to chief/Land Allocation Committee
- The Land Allocation Paper is issued to the developer
- The Developer verifies the status of the plot at the District Town and Country Planning Office
- A payment of drinks money is made at the *Asantehene*'s Land Secretariat for the lease
- The District Assembly makes the decision through the relevant officers
- A permit is issued to the developer by the District Town and Country Planning Office
- The development takes place

2.4 Catchment Surface Protection: Soil Erosion Control

2.4.1 Introduction

This section offers the community leaders practical information that can be used for soil erosion prevention and control. The notes will assist local people to use simple technologies to rehabilitate eroded land and to help prevent soil erosion in the community.

Approaches to reducing the effects of soil erosion include engineering methods and agronomic solutions. Examples of engineering methods include land levelling, construction of contour barriers, construction of drainage channel. Agronomic practices would include grassing and agroforestry systems.

2.4.2 Importance of soil

The soil is one of the most important of all natural resources. It is vital for all living organisms and major ecosystems, as well as for food production, development and growth of settlements and population distribution. The soil supports plants, animals and human life. However, in many communities poor soil management has caused excessive erosion. The impact of accelerated soil erosion on village water supply, streets and housing and the impediments it causes to human and vehicular movements requires that urgent measures are taken to prevent and control soil erosion. Effective management of soils can reduce on site and off-site impacts of erosion.

2.4.3 Soil erosion defined

Erosion is the washing away of topsoil when there are not enough trees or other plant cover to absorb the impact of rainwater. It is that physical process by which soil material is carried away by water or by wind. Erosion by water is the result of raindrop action and surface runoff and is recognized in one or more combination of forms: sheet, rill, and gully erosion. In wind erosion, varying quantities of soil are removed by force of wind.

Sheet erosion refers to the removal of a thin layer of soil, more or less uniformly, from the entire surface of an area. It usually occurs on ploughed fields that have been recently prepared for seeding, or after the crop is seeded and before crop canopy covers the soil. It is also common in new settlements. The loss of topsoil may be serious and can affect fertility of soils for backyard gardens.

During heavy rains, runoff water is concentrated in small streamlets. As the rate of runoff increases, the water erodes small channels called rills. Erosion of this type can remove large quantities of village soil and rapidly reduce soil productivity. If conservation measures are not taken to prevent further loss of soil, rilling continues year after year until the topsoil is removed and village streets develop potholes and gullies.

Gully erosion occurs where the concentrated runoff is sufficiently large to cut deep channels not crossable with vehicles. Continued cutting in the same channel deepens the incision. Once started, gullying proceeds rapidly, particularly in soils that do not possess much strength to resist erosion. Gully erosion requires intensive control measures, such as terracing or the use of waterways, diversion ditches, or check dams.

2.4.4 Effects of soil erosion on fertility

Erosion affects soil fertility in a number of ways:
- loss of nutrients and the more physically mobile particles of soil through the action of water and wind
- surface crusting of the soil, impeding crop germination and emergence of land cover (grass)
- leaching of nutrients down the soil profile, out of the reach of plant roots.

The type of crops or land cover, the systems of management, land use, and supporting conservation practices influence the amount and type of erosion. Bare soils, overgrazed uncultivated soils and trampling by foot and animals permit the greatest amount of erosion.

2.5 Water Resource Protection

Some basic rules for protecting water resources are set out in section 3.5. However, water resources are in many ways the most difficult to protect against deterioration since the source of the problem may be remote from the community affected. This fact, coupled with the fundamental importance of water for human consumption, agriculture and hygiene, means that communities need to consider threats to the water resource in a *catchment* context. All rainfall which falls on the earth is either evaporated back to the atmosphere, percolates into the soil forming the groundwater resource or runs over the land surface into rivers. The land which contributes runoff to a river is known as the *catchment*. Since water always flows downslope streams carry relatively little water in the upper (headwaters) catchment and accumulate more flow as the area drained increases downstream. Hence, activities harmful to water quality in the upstream part of a catchment will inevitably cause poor water quality for communities downstream.

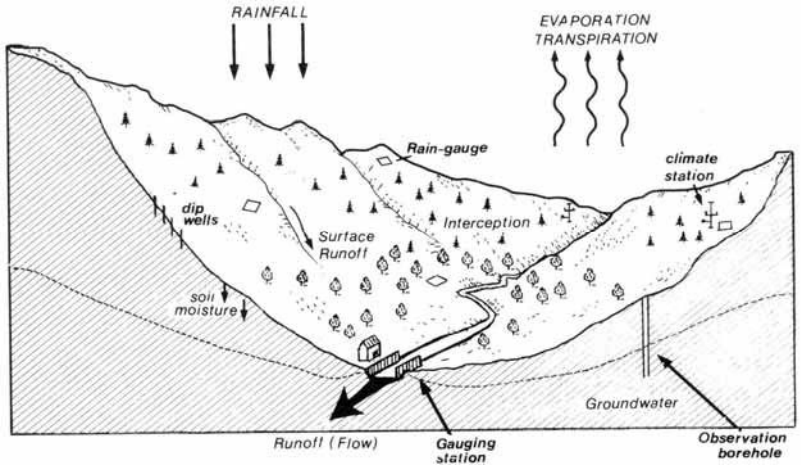


Figure 2.1: The Catchment Hydrological Cycle. The diagram shows the main flows of water.

The catchment hydrological cycle is illustrated in Figure 2.1. It is important to note that as well as the linkages between surface water on slopes and in rivers, there is also a vertical movement of water into the soil and to groundwater stores. Groundwater is the source of borehole and well water supplies. Contaminated water standing on the surface will eventually percolate into the soil and may pollute groundwater supplies. Long term dumping of waste in the same location or poor siting of latrines or sewage settling ponds threaten groundwater quality unless measures are taken to seal off the waste from deep water percolation.

In practical terms, the Communities must consider whether the locations of different activities are likely to lead to pollution of water resources within their own environment and *for those living downstream.*

Activities can be considered in terms of their location with respect to the river channel and the *timescale* over which the activity occurs, continuous or discrete. For example location of agriculture, latrines, waste dumps, sewerage treatment and car repair may be considered long term activities which are effectively continuous sources of pollutants to rivers and, potentially, groundwater. Other activities, such as washing utensils, car washing, bathing etc are short term and often spatially non-specific in terms of location. These may cause temporary harm to river water quality if located in the wrong place but are less likely to cause deterioration of groundwater supplies.

2.6 Waste Disposal Management

2.6.1 Introduction: What is waste?

Waste refers to any material considered to be no longer useful and which may be dumped and thrown away.

If waste is not handled properly it can pollute the environment, the land, air and waterbodies, thus impacting adversely on public health.

At a workshop organised for District Environmental Management Committees of the eighteen districts in the Ashanti Region, poor sanitation ranked among the first three environmental problems in most cases.

Proper waste disposal has become a serious environmental problem in the Kumasi metropolis and its surrounding towns and villages.

2.6.2 Types of waste

There are two main types of waste: solid and liquid waste.

Solid waste refers mainly to:
- domestic waste (waste from food preparation, sweeping, discarded household items)
- municipal waste (waste generated in commercial centres)
- industrial waste (e.g. wood waste, waste from abbatoirs and food processing industries, metal scraps from garages)

Liquid waste refers mainly to
- industrial waste (i.e. effluent from industrial activities)
- human waste (excreta)

2.6.3 Identification of the problem

The disposal of waste causes numerous problems in peri-urban Kumasi. Poor handling, treatment and disposal of waste stems from a variety of economic, social and cultural conditions. With an increasing population, there is a resultant expansion in land used for many socio-economic activities in the Kumasi metropolis and peri-urban area. Conversion of agricultural land to residential and other uses can have severe repercussions in terms of waste production.

2.6.4 Problems of pollution can be attributed to:

Poor Domestic Waste Disposal
- lack of demarcated sites for refuse disposal
- relatively inaccessible refuse dump sites
- lack of awareness of the health implication of insanitary practices
- indifference to the presence of waste
- lack of the requisite equipment for disposal

- poor siting of refuse disposal sites (e.g. along river banks and marshy areas, near water sources)
- lack of the technical know-how to add value to waste (e.g. composting)

Poor Human Waste Disposal
- absence of private toilet facilities in most homes
- absence of public toilet facilities in certain communities
- inaccessible public toilet facilities, in terms of distance, in some communities
- ignorance of health implications of indiscriminate defecation
- indifference to consideration of hygiene
- poor maintenance of public toilets
- littering, especially polythene products

2.7 Water Harvesting

Boreholes and hand-dug wells fitted with pumps will supply potable (drinking quality) water suitable for all domestic purposes. River water can be used for irrigation of crops or kitchen gardens. However, some villages are still without a borehole or hand-dug well fitted with a pump, or those which do have them often find that demand for water leads to queues. Long queues for the borehole may lead some villagers to collect water from polluted sources such as contaminated rivers. Also, use of heavily polluted river water for irrigation may lead to some contamination of crops, particularly vegetables.

The question therefore arises, are there alternative supplies of clean water which could replace use of river water and reduce pressure on boreholes (at least until the number of boreholes provided is increased or piped water supply reaches peri-urban communities)?

One possibility is to make use of water collection strategies known collectively as *water harvesting* - the collection of rainwater and runoff from a small catchment. The catchment may be a field, a natural land surface draining to a water collection area, a road or a roof.

The two factors which determine how much water a catchment/roof can supply are the *area* and the *losses* to infiltration, spillage and evaporation. It follows that the most efficient collection of water will come from surfaces which are compacted or impervious. Compacted *bare soils* are often available in villages along the main roads where continuous traffic and trampling by people and animals have removed vegetation and have crusted the soil surface. However, these surfaces may often be uneven, which means that runoff may be dispersed over a wide area and difficult to direct to a central collecting tank.

There are three main methods of rainwater collection:

1. Runoff-farming: An external catchment supplies overland flow which is routed to the collecting area or crop-growing area. The size of the external catchment is usually relatively large and measures must be taken to route the runoff to the collection area and to prevent significant infiltration losses. Whilst used in many semi-arid environments (including the Sahel), runoff farms require relatively large labour inputs and land requirements. Runoff farming is also more appropriate to agricultural application where rainfall is limited rather than the seasonally humid environment experienced around Kumasi. It is important to distinguish the fact that water *supply* is constrained by its *quality* in Kumasi rather than by climatically induced *scarcity*. Hence runoff-farming is not considered further as a viable strategy for increasing the supply of good quality water for domestic use in the Kumasi area.

2. Micro-catchments: Micro-catchments are usually designed for supply to kitchen gardens or other small cultivation plots and, less commonly, for domestic supply. The area of ground utilised may be natural topography or covered surfaces such as car parks, roads or courtyards. Ground catchments are less expensive than roof catchments (see below) and can provide a larger catchment area, and potentially more water, although losses may be greater than in the case of a roof. However, water running over a natural or man-made surface is more likely to be contaminated and should not be used for human or animal consumption without boiling. Ground catchments also require careful thought to be given to the location, safety and possible contamination of the storage tanks. The catchment area also needs to slope towards the collection/storage tank. This may require some labour to landscape the catchment by moving soil or making conduits, which may impose some cost constraints. Bare rock surfaces provide efficient means of collecting runoff.

3. Roofs: Roofs are the most convenient and common method of providing a catchment area to harvest rainfall. A variety of materials are suitable, including corrugated iron ('zinc'), plastic and tiles although

the iron can be expensive for some communities. Grass-thatch can be used if no other materials are available and the use of lead must be avoided. Water running off the roof is collected by suspending gutters from the house eaves. These need to be suspended at a slight angle to route the water to the collecting tank. The tanks might be plastic, ceramic or galvanised zinc. Consideration of storage times, prevention of contamination, mosquito breeding and stagnancy are important where water is to be used for human consumption. However, stored water could be used for other domestic purposes such as washing utensils, bathing, or irrigating kitchen gardens, to reduce pressure on local boreholes, which could then provide water primarily for drinking and cooking.

Roof/catchment size and rainfall intensities, seasonality and totals and storage capacity of tanks will determine the extent to which water harvesting can meet the demands of a given community. Other questions to be resolved include: Will all houses be used to collect rainwater? If the answer to this question is *'no',* how will collected water be distributed amongst the community or will it be a case of individual households collecting their own water?

In order to implement a successful water harvesting strategy, it is essential that an estimate of the water use of families is made to which the supply capacity of the catchment or roof can be compared. It may be useful for a community survey to be carried out to establish the daily demand for water for different activities. Estimating the water which can be supplied from roofs would require some rainfall figures (which are available locally from Kumasi airport weather station, and past records are held in KUMINFO at IRNR) as well as a survey of roof areas within the community. Since the collection potential for a roof should be high, communities should be able to estimate likely harvestable water from roofs.

Once the likely supply and demand figures have been estimated, it is also necessary to determine storage requirements. Storage may be in excavated tanks or in simple cisterns or plastic water butts (tanks). Storage volumes will depend on the difference between total incoming harvested rainfall, the storage capacity of the container(s) and the daily demand pattern by the community. The affordability of different storage options and/or the labour requirements for maintenance will be factors for the community to consider.

2.8 Environmental Self-Monitoring

There are a number of simple ways in which communities can monitor their environment. Evidence of declining water quality can be indicated by changes such as:

smell
visual evidence of increased pollution such as increased levels of garbage, floating faeces, change of colour due to human or chemical discharges, increased turbidity, persistent foam on water surface, oily films on water surface
dead or dying fish
decreases in other water animals
changes in water vegetation such as appearance of algal blooms, increases of plants such as water hyacinth

Evidence of increased soil erosion on land includes:
the appearance and enlargement of gullies
progressive exposure of tree roots
progressive washing out of fine materials on the slope
progressive silting up of ditches

It is also important to monitor the land surrounding boreholes and wells for evidence that water from polluted locations, such as latrines, washing areas or car repair areas is contaminating the water source. The danger of contamination is increased if latrines or other polluting activities are located *upslope* of wells or boreholes.

A more rigorous method of testing water quality has been piloted in five JSS schools during the course of this Project, the Somerset Educational's *MicroChem Field Kit*. This kit is available in Ghana through T-Mark Educational Services Ltd (see Directory) and comprises a wide range of tests of water conditions.

The kit provides quantitative measures of the following parameters:

- pH
- Turbidity
- Water temperature

and a qualitative assessment of:

- Coliform bacteria
- Dissolved oxygen
- Electrical conductivity
- Nitrite
- Nitrate
- Orthophosphate

Technical support and backup has been provided to the JSSs by EPA and Ghana Water Company.

2.9 Responsibilities of Stakeholders

Stakeholder involvement: who and at what level? These questions are addressed in Section 5, and reference should be made to that Section of the WMF.

2.10 Consultation Mechanisms

There is a need to establish clear procedures for reporting environmental problems. This starts at the level of each individual within the community, and passes through the community committees and Environment Officer/facilitator to the chiefs and elders of the community. The assemblyman/woman is a vital link to authority, and various agencies such as EPA.

Information on how consultation can be carried out is included in Sections 5 and 6 of the WMF. See, for example, Section 5.1 on the roles and responsibilities of individuals and organisations; and Section 6.2.4 on deciding which is the appropriate organisation to approach with a given problem.

ADDRESSING THESE PROBLEMS WITHIN THE WMF

3.1 Introduction

This section presents the practical problems faced by communities in relation to the range of issues which arise in the processes of resource use and land use change.

In each section typical problems are presented and possible solutions are suggested. The order of sections is the same as in Part 2 of the WMF, and cross reference should be made where necessary.

This section of the WMF is, in effect, a 'best-practice' manual. Users are encouraged to consider adapting the recommendations herein, to help them address problems which do not fall into the categories outlined here, or where new problems arise. It is meant to be a document which can be amended to suit local and individual circumstances, or to address new problems not as yet covered by the document.

Cross-reference should also be made to the 'Best Practice' Handbook of Watershed Management produced for community use, where a number of the main issues regarding protection of the environment and the water resource have been illustrated.

The CWSA/IGIP WATSAN Manual covering a range of important hygiene and sanitation issues has been issued to the communities participating in this Project, asnd should be used in conjunction with the Communities' Best Practice Manual.

3.2 Land Use Criteria

3.2.1 What are the problems with land management?

Problems affecting proper land management in peri-urban communities include:

- Conflict of interest among chiefs, families and other stakeholders over land use
- Litigation over land ownership
- Unequal Access to land by the majority of the people
- Unauthorised use of land, particularly encroachment of reserve areas
- Sale of land on floodplain areas and adjoining water-courses
- Resource exploitation (eg sand winning) without proper rehabilitation measures
- Weak enforcement of existing legislation

3.2.2 What needs to be done?

- Chiefs are to involve communities and all other stakeholders in land management
- Ownership of land should be well determined and respected by all
- Access to land particularly by local people must be assured
- Rules governing use of land should be strengthened to protect reserved lands, wetlands and water bodies
- Approach the news media to get newspaper/radio/TV coverage of any serious dispute or major problem
- Proper enforcement of legislation with the agreement of the range of stakeholders involved

3.3 Land Allocation Procedures

3.3.1 What are the problems with preparation of layout plans?

Problems associated with preparation of layout plans include

- Poor interaction between the community and District Administrations
- Lack of consultation between the chief and the community
- Inadequate data on areas to be zoned and poor knowledge of communities by Planning Officers
- Involvement of unqualified/unregistered planners in the preparation of layout plans for some communities

- Inadequate briefing of chiefs by planning officers
- Lack of education to sensitise chiefs of procedures for preparation of layout plans

3.3.2 What needs to be done?

- District Assemblies should take the lead to establish good communication links with traditional authorities on issues concerning the preparation of layout plans
- Traditional rulers should consult with their communities to agree on details of layout plans
- Part of the District Assemblies' common fund should be put aside as revolving fund to support the preparation of layout plans in communities
- Adequate data and good knowledge of areas to be zoned are necessary for the preparation of good layout plans
- Qualified surveyors and planners must be engaged by traditional rulers to prepare layout plans
- District Assemblies are to mount educational programmes to educate chiefs on the importance of good layout plans

3.3.3 What are the problems with land allocation?

- Increased land speculative activities
- Multiple land sales of the same plots by land owners to unsuspecting developers
- Conflict of interest over land use
- Lost of farm lands to the poor and inadequate or no compensation to them
- Lost of community land of indigenous people to migrants
- Cumbersome procedures for land allocation
- High fees charged by landowners

3.3.4 What needs to be done?

- Chiefs and all stakeholders involved in land allocation should ensure that the same plot of land is not sold to more than one person
- Adequate provision should be made for different uses of land to avoid conflict of interest over land use
- The interests of the people who depend on land for their livelihood, particularly farmers, should be taken care of in preparation of layout plans
- Streamlining of procedures to ensure transparency in land allocation

3.4 Catchment Surface Protection

3.4.1 Soil Erosion Control: Causes of soil erosion and recommended measures

Soil Compaction
Soil compaction reduces the ability of soils to absorb moisture and can result in increased erosion from water runoff during the rainy season. This may be caused by overgrazing and, in villages, by people walking on specific pathways.

Recommendation: keep plant cover, possibly grass, wherever possible; provide paved footpaths.

Bush Burning
Soil erosion as a consequence of bush burning and land cover degradation. Soil structure may be damaged and organic matter content may be reduced, leading to compaction or crusting. Runoff may be increased as a result. Loss of litter cover may lead to increases in the speed of runoff, which may also encourage erosion.

Recommendation: Burn as little as possible.

Regular Sweeping around the Compound
When compounds are cleared of vegetation through regular sweeping or weeding, bare surface becomes exposed and susceptible to soil erosion.

Recommendation: Maintain grass cover around compounds and open spaces. Plant grass and avenues of trees.

Rain Drop Impact
The impact of rain drops on a bare surface will cause compaction (see above), and will also result in the removal of loose soil.

Recommendation: Attempt to maximise grass and vegetation cover within and around the village.

Lack of Roof Gutters
When it rains, the rain that runs off roof tops can cause concentrated soil erosion around the foundations of buildings, and may also cause gullies to form.

Recommendation: Harvest water from roof tops (this water may be used for domestic purposes). Construct roof gutters and direct water from rooftops into street drains.

Simple methods of erosion control

In the past, many local efforts of community soil erosion control have focused on physical checks to runoff and the barrier approach. Equal attention needs to be given to maintenance of ground surface cover of living and dead plant material. Crops that give complete ground cover throughout the year, such as grass or forests, are effective in controlling erosion.

Development officers and town planners should decide which ones are most useful for their communities, which have been used successfully in the past, and which are the most acceptable to local people. Some examples of specific mechanical and improved tillage methods include:
- land levelling
- grassing
- pegging with bamboos
- roof gutters with gravel pits as soak away
- construction of earth-drains using boulders
- boulders lining of foundations
- landscaping around houses using colourful hedges and grasses.

Conservation tillage includes a variety of no-plough systems to retain residues on the surface. This helps to retain soil moisture in drier periods.

Rotational cropping aids in controlling plant diseases and control of pests.

Contour ploughing and contour barriers both help to prevent downslope soil erosion.

Animal manures, ploughed into the soil, help to maintain a good soil structure and reduce erosion. The diagrams below show some of the measures which can be taken to reduce the rate of soil erosion.

Simple barriers across the slope (Figure 3.1) prevent the accumulation of runoff on the soil surface and reduce surface water flow velocity. The combination of reducing velocity and water accumulation reduces the erosion potential of the overland flow during a rainstorm.

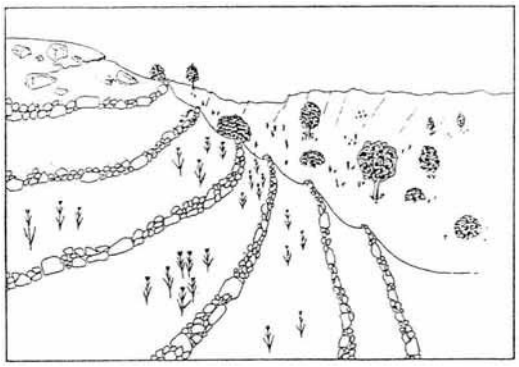


Figure 3.1: Contour barriers

Figure 3.2 shows a method of reducing erosion on steeper slopes. The trenches break the slope up into small sections to prevent accumulation of runoff while the brush bundles act to reduce the flow velocity of water entering the trench and encourage deposition of any soil which the water has eroded from upslope.

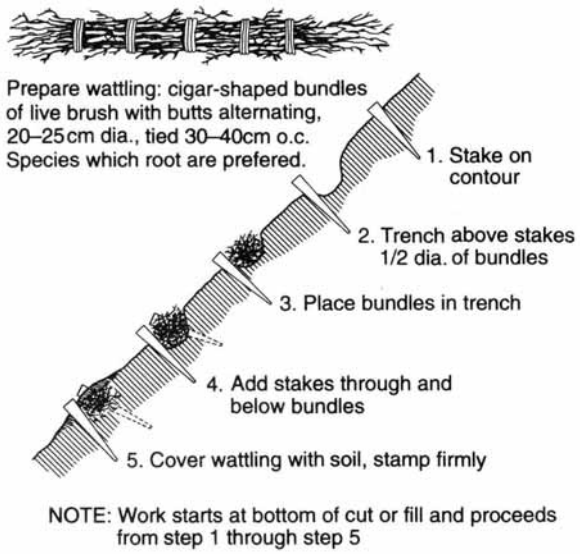


Figure 3.2: Contour trenches with brush bundles.

Many of the villages near Kumasi experience severe erosion on the roads during rainstorms, leading to severe gullies passing through the Community and between houses and buildings. This erosion results from devegetation and compaction of the soil surface by vehicles, livestock and the everyday activity of people walking along the road or between houses. Waste water poured onto the street by residents may start to wash away the soil surface leading to depressions which form the focus of intense erosion (and gullies) when the rainy season arrives.

If left unchecked, gullies can destroy roads and fields and lead to severe reductions in soil fertility. Figure 3.3 shows a method of stabilising gullies by building a porous barrier to reduce water velocity and encourage the deposition of soil within the gully. Eventually the gully will start to fill. A cross-section looking from the front of the structure is shown at the top of Figure 3.3, below that is the side view, and at the bottom of the diagram is shown the plan view looking from above the structure.

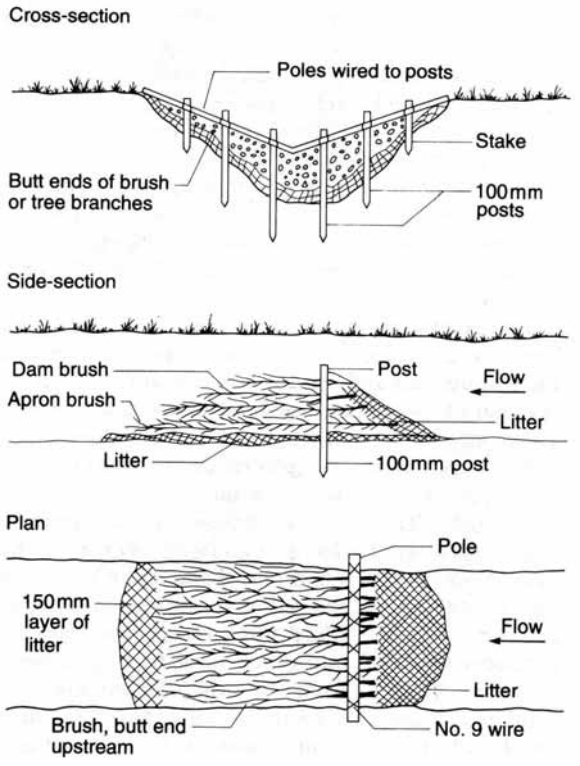


Figure 3.3: Gully damming using a post and brush scheme.

Figure 3.4 shows how gullying of roads can be treated by the building of 'cut-off drains'. Again the principle is to prevent accumulation of runoff and reduce its velocity.

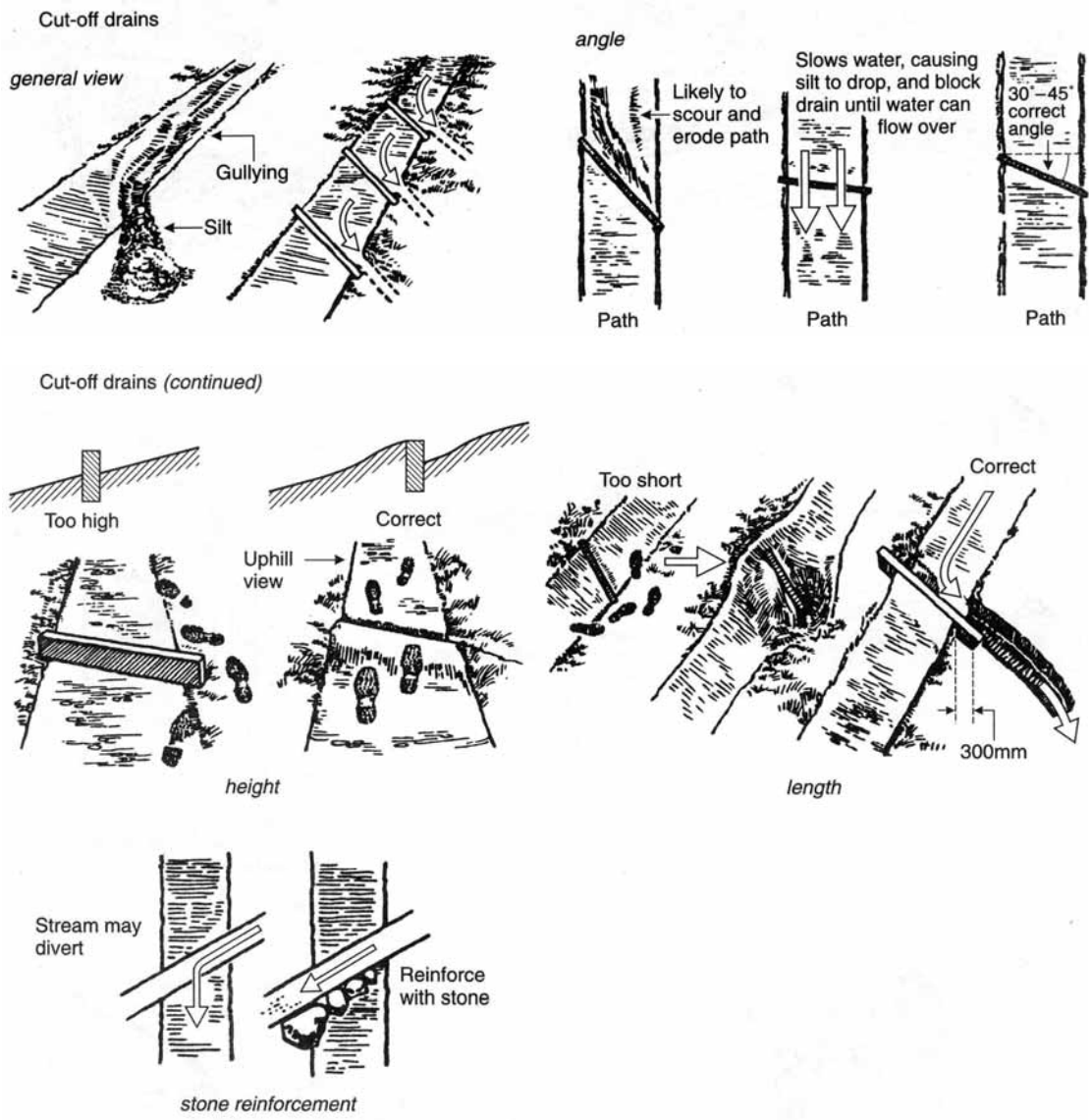


Figure 3.4: Cut-off drains to reduce erosion of paths and unsurfaced roads.

Agroforestry techniques for catchment surface protection

By far the best protection of the land from erosion is to let natural vegetation colonise the land surface. However, it is realised that, especially in the peri-urban zone, the pressures of land for agriculture and building are intense. It is not therefore practical to allow large areas to return to natural vegetation. What can be done, however, is to use trees and bushes around houses and in fields (particularly on sloping ground). The science of Agroforestry uses trees and bushes in among crops, or on field boundaries, or around houses, in ways which protect the land from the worst effects of soil erosion.

Planting trees and bushes not only slows down erosion rates, but provides shelter for growing crops, fuel wood, and stakes for building or fencing. Some species also produce food (fruits, nuts and seeds) for humans and domestic animals, and fodder for animals, and are therefore of economic value. Some trees and bushes can even be used to provide medicines to treat a range of sicknesses and infections. Some species help to promote soil sustainability as they fix nitrogen and have a positive impact on soil fertility.

The presence of trees around the house and in the village also promotes a sense of well-being. They are pleasing to the eye, and often sweet-smelling. They can be used to screen rubbish dumps and latrines, and help to reduce the smells from these.

Alley cropping and contour farming

In most cases poor farming practices promote soil erosion on farmlands that have even moderate slope gradients. Year in and year out soil is lost to such farms and rills turn into gullies eventually destroying the farmlands. This process of land degradation is common in areas that are steep with sandy soils and without adequate tree cover. The yields of crops on such farms decline steadily until they are no more economical to be cultivated.

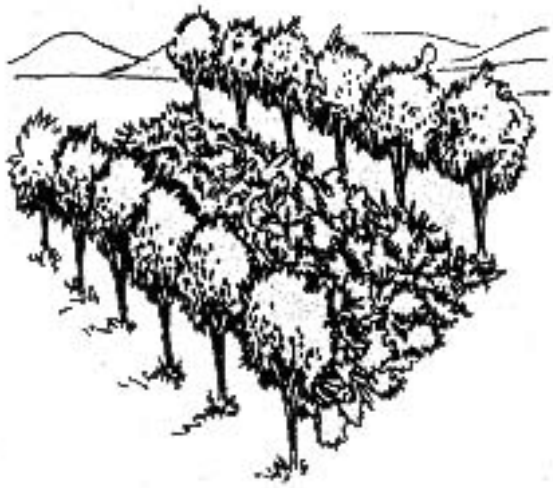


Figure 3.5: Screening your vegetable plots with trees helps to shade and protect them. Add low-storey bushes, and you can also keep out goats and cattle

Figure 3.6: Planting bushes along the contour is an effective way of reducing soil erosion.

Replanting trees in rows to form alleys on such lands even with gentle slopes may help restore the productivity by stopping erosion and keeping the top soil in place. This technology is called alley cropping and it combines food crops, which are grown in the alleys formed by the establishment of tree or

shrub hedgerows along the contour. The trees or shrubs are established in single or multiple rows. Alley cropping can be practised by many of the farmers in the peri urban areas where the small-scale farming is done on plots as small as half an acre (0.2 ha).

Good alley cropping species include *Leucaena*, *Gliricidia and Acacia albida*.

Home Gardens

Many compounds in the homes of people living in the peri urban areas in Kumasi have very bad erosion and other environmental degradation problems. In addition they do not have assess to shade. The records show that they also have nutritional problems. Many people also have poor access to money and income generation is very low or non-existent. The wastes from these homes are not properly utilised and cause a pollution problem. Agroforestry could be used to solve some of these environmental and socio-economic problems.

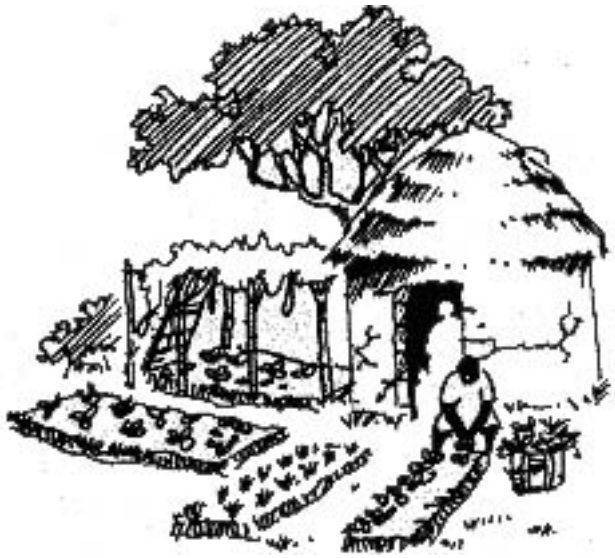


Figure 3.7: A home garden

Trees can be planted in home gardens and yards to provide shade, fruits, medicines, vegetables, fodder, fuel wood and other products for use in the home. These are very important and useful attributes of the home garden technology that provide service roles in addition to these useful roles. A well-developed home garden allows for the control of soil erosion. Most of the organic waste could be used as compost or put directly into the soil. For those who value nature home gardens provide aesthetic values also.

Mango, tamarind, banana, plantain, pawpaw, cashew, avocado pear, guava, orange, etc are all good trees for home gardens. Other trees like neem are also very important.

These are combined with vegetable crops and small animals to form a good garden that is sustainable.

Woodlots

Many of the communities are engaged in activities that generate income as the natural resources are utilised in the production of goods as beads, pots, palm oil, palm kernel oil, kenkey and other foods. These use a lot of energy in the form of wood as the major source of energy. The wood used to be obtained from the wild. The records show that the peri-urban areas do not have as many trees as there used to be. The sources of energy have diminished at such a fast rate and it is time to do something about it. Woodlots can be developed to provide the wood needed for these enterprises.

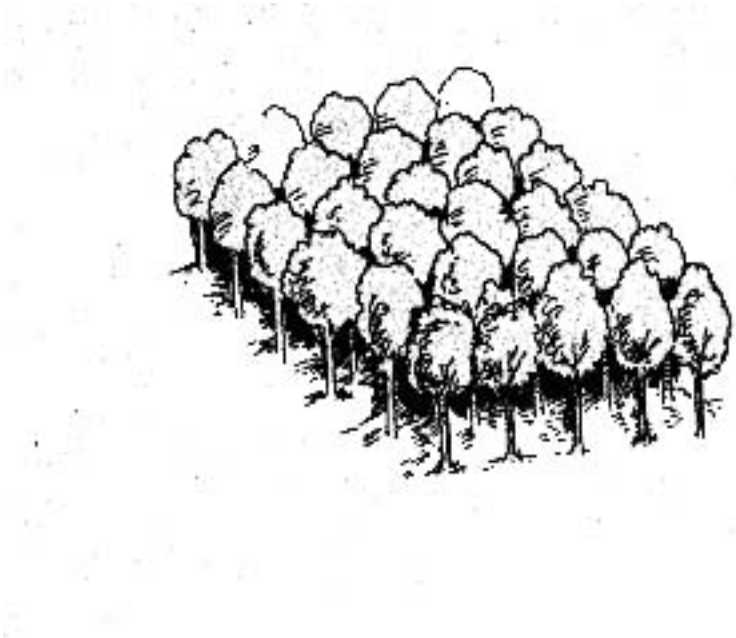


Figure 3.8: Growing woodlots helps to protect the natural forests by providing a source of wood for fuel and other uses.

Many species are fast-growing and can be planted in a woodlot. A woodlot contains woody perennials and serves as a principal source of wood. It can be managed over time in association with crops and animals. A woodlot keeps the soil surface covered and serves as a soil and water conservation measure. Woodlots help rainwater to infiltrate the soil. The trees also help to absorb carbon. A good crop rotation makes woodlots a sustainable venture and very environmentally friendly.

Tree species like *Acacia auriculiformis; Cassia siamea* and neem are all excellent for woodlots.

Windbreaks

Many of the peri-urban communities experience very strong winds and sometimes very serious wind damage is caused to roofs, especially of school buildings. Sometimes farms also experience wind damage and crops lodge to the extent of total loss. In many communities dumpsites are used to dispose of waste effectively but this is invariably a source of strong foul smell. Strong winds also blow the smell far and sometimes this comes with some particles from the waste sites. This could be injurious to the health of people in the respective environment. The dumpsites are usually eyesore sites for many communities.

Figure 3.9: Windbreaks are strips of trees or shrubs planted to protect areas (e.g. fields and homes and around areas that have to be hidden from public normal view). The trees protect these areas from strong winds and prevent soil erosion due to wind. They also slow down winds so that they do not have adverse effects on building, especially roofs. When suitable trees are planted around dumpsites they act as windbreaks and provide an added aesthetic value.

Live fencing

A major problem in many of the peri-urban communities is the free-range method of livestock rearing. The sheep and goats are a particular nuisance. They trespass into people's home compounds and pollute rivers and water bodies. They invariably browse flowers and crops of other people and are a constant source of dispute among people. In addition they are a threat to motorists.

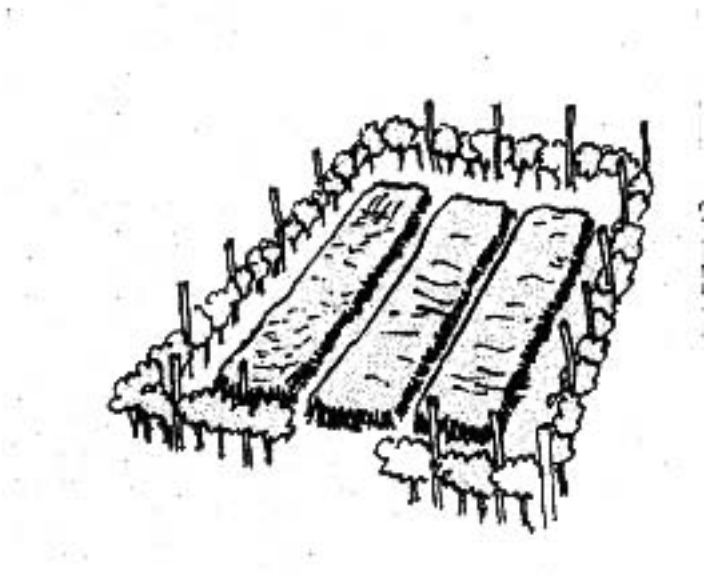


Figure 3.10: Live fencing is an easy and economical way of keeping both animals and humans from trespassing. It also provides an easy means of keeping sheep and goats in confinement, or keeping them out of areas such as dumps and latrines. The fence itself can be aesthetically pleasing when well trimmed.

Trees can be grown on the home compound or farms, usually combined with other plants as a live fence. This is done at a planting spacing that would keep animals in or out. Live fences are less costly to install and are easy to maintain. They may play one role or the other depending on the choice of species and the pruning may be used for fodder or for mulching. Some trees in the fence may produce beautiful flowers. The fence also provides some privacy. Other areas like the dump sites, water wells and recreational parks may also be fenced. Along the fence line a combination of trees may be used. The large trees may be spaced 5 metres apart and the smaller trees may be spaced 15cm apart .

Many tree species may be grown as live fences including *Acacia nilotica, Cassia siamea, glyricidia*, madras thorn etc. The fence may be strengthened with barbed wire, especially if the control objective includes keeping human beings out.

Boundary Planting

Poor demarcation of boundaries gives rise to problems of bitter and long disputes among neighbours. Planting trees along boundaries could avoid this.

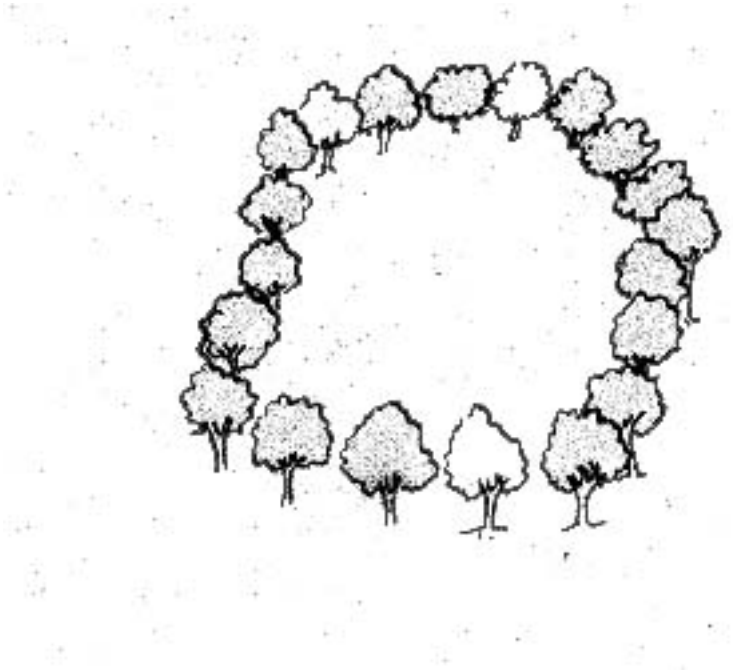


Figure 3.11: Boundary planting is very similar to the live fencing but the trees need not be that closely spaced. Traditionally some plants have been used as markers for boundaries. This traditional ecological knowledge is applied as shown here, and multipurpose trees can be used. The trees and also help reduce erosion from one field to the next. The trees may also provide products like fuel wood, fodder and fruits. The trees may also be a source of medicines. Boundary plants may also be useful as shade plants, especially on the compounds of institutions such as churches and schools, and along roads and paths.

Many tree and shrub species may be planted as boundary planting including, neem, glyricidia, madras, meligna, spondias, eucalyptus, etc.

Trees dispersed on croplands

As lands are cleared for farming, the peri urban areas have become treeless. The rest of the land has invariably gone into other developmental projects. The lack of trees on the croplands leaves the lands bare and prone to environmental hazards. Many farmers would prefer to have a few trees on their farms.

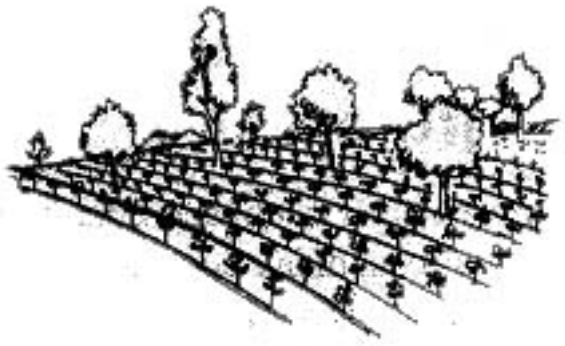


Figure 3.12: Dispersed trees

In this technology, the trees are scattered so they do not cause any serious shading problems on the crops. An optimal tree population is maintained. The trees may provide fruits, some shade, fertilizer, stakes, etc. These may be enough for the farmers to forgo the relatively insignificant loss in yield of the crop plants.

Individual farmers may plant any of the several available tree species on their croplands. The farmer's choice will therefore rely heavily on the service role or the products to be derived from the trees. Trees

with light canopies like eucalyptus, orange, oil palm, and even some timber species may be planted. The trees that may grow too heavily in the crown may be pruned to a suitable crown size.

Rehabilitation of sites degraded by sand winning

Areas suitable for sand winning are most frequently found in low-lying stream floodplain areas, although in the Kumasi area some hilltops are capped by lateritic gravels which can be used for roadmaking. Most of the degradation that occurs in sand winning areas is based on the removal of sand to be used on sites usually quite far away. Trees and shrubs are first removed and the 15cm topsoil, which has an amount of organic matter, is also scooped off and put out of the way of excavations. The excavation of the sandy subsoil is then undertaken, until large pits are left in what used to be a fairly level landscape.

It is necessary that the degraded areas are properly demarcated and their rehabilitation properly planned. Several choices may be available to the community or the individual who may wish to rehabilitate the degraded area, and a well thought through analysis must be done. The eventual use of the resource, the objective of the user and the actual financial resource available must be taken into consideration. One of the following options may be considered:

- use the area as landfill (using solid waste or construction waste materials) for long-term reclamation of the degraded site and the opportunity to dispose of solid waste
- level the area for building and other infrastructure development (but not close to a river or other water body used by people
- level the area for the planting of trees especially in the reclamation of degraded watersheds
- level the area for the restoration of farms in the areas that were previously farmland

3.5 Water Resource Protection

As outlined in Section 2.5, water resource deterioration often occurs because activities are located in the wrong place, for example too close too, or upslope of, a river or borehole. In this section we have outlined some of the problems which result from activities close to specific types of water resource and the ways in which contamination may be reduced or avoided.

A number of these problems are illustrated in the Communities' Best Practice Manual. The CWSA/IGIP WATSAN Handbook should also be referred to in this context, particularly with respect to issues of hygiene and sanitation.

3.5.1 Streams and rivers

Streams and rivers provide drinking water for many communities and are also used for bathing, irrigation of crops and as a source of food. Sources of poor stream water quality include the following:

Latrines/sewage dumping

This can lead to bacterial infection if the water is drunk or swallowed while bathing, or used for washing utensils or clothes. This may also infect crops if used for irrigation. It is essential that latrines and dumps are kept well away from sources of water for community use. The CWSA/IGIP WATSAN Handbook recommends a minimum distance of 100 feet (30 metres).

Agriculture

Fertiliser applications may lead to poor river water quality if fertilisers are washed into the stream, or seep in shallow groundwater flow, during wet season rainstorms. Nitrates and phosphates are the main pollutants. Wherever possible, heavy applications of inorganic fertilisers should be avoided close to rivers or other water bodies.

Car washing or repair

Car washing in streams is a common activity in peri-urban Kumasi. Oils, grease and detergents are washed into the stream, and carried downstream to pollute other people's water. It is recommended that an area be set aside for car washing, at least 100 feet (30 m) from any source of water.

Personal hygiene/washing

Bad use of the water bodies by individuals, including urination and defecation in the water body or on its banks, washing clothes or cooking utensils in the water. Bathing directly in the stream is also bad practice, as many diseases can be transmitted in this way (see WATSAN Handbook). All of these practices should be banned from the banks of water bodies, although it is recognised that this will require careful thought on the part of communities as to how to provide alternative facilities without incurring significant expenditure.

To reduce the likelihood of pollution from the above activities, it is essential to think about *where* the activity is located with respect to the water body, and bearing in mind the local topographic context. Any activity located on a slope draining directly into a stream may lead to pollution unless the runoff containing the waste is prevented from reaching the stream.

Trees along waterways and on flood plains

It is important that waterways are protected. In many waterways and flood plains there has been so much degradation that one is inclined not to even recognise them as having anything to do with water. The trees have been cut and the vegetation burnt. There is so much erosion along the riverbanks and they often cave in and the rivers become silted. As a result the rivers dry up very early in the dry season and there are problems of inadequate water supply. There is always a problem of flooding in the unusual years when rainfall is intense within short periods. In very unusual cases destruction of the floodplain has been initiated by the construction of buildings and other infrastructure in these rather fragile areas. The dumping of industrial waste, such as sawdust and shavings into rivers also cause degradation.

Figure 3.13: Trees planted or protected along waterways and on flood plains help to protect the environment.

The degraded areas must be demarcated and further destruction stopped by community byelaws. The rivers can be rehabilitated if the catchment area is protected. Cropping and indiscriminate disturbance of the soil must stop. If at all possible, such areas must not be sold for building and there should be no permits issued for such development.

Agroforestry technologies may be used in many of thse rehabilitation exercises. Some trees are tolerant of marshy or water logged areas and can be grown along rivers or streams and in floodplains. Trees that are useful and effective in these areas include *Glyricidia spp., Aconia cordifolia*, Eucalyptus spp. etc. Woodlots may also be developed in such areas.

Boreholes and wells

The quality of water in wells may be affected by large-scale, long-term seepage from, for example, urban sewage dumps unless these dumps are effectively lined and managed. Locally, the main threat of contamination comes from material dropped into the well, or from poor hygiene from those collecting well water. It is essential to cover the well when not in use, and the use of one fixed bucket to draw water from the well is strongly recommended. Simply washing hands may be an effective way of protecting well water supply. Surrounding slopes should also be managed carefully. Siting latrines or washing areas close to the well is hazardous (particularly a short distance upslope of the well).

For boreholes, the main source of infection may well be poor hygiene of those collecting water. For example, failure to wash hands after using the latrine followed by handling of borehole water buckets may leave bacteria to infect water when the bucket is used to carry water from the borehole. The location of cemeteries, waste tips and latrines upslope of a borehole may also cause long term deterioration in groundwater quality due to the leaching or seeping of contaminated water.

Springs/source areas

Springs and stream source areas should be kept clean to prevent deterioration of water quality and pollution downstream. Siting of latrines, waste tips, cemetaries well away from source areas, and prevention of random defecation/urination in source areas, is strongly recommended. Washing of cars and bathing should not be carried out in locations which provide water for human consumption or which is used for cooking.

Importance of appropriate land use

Planning the location of specific land uses with regard to potential water quality protection is the best way to improve water quality in the long run. However, it is recognised that this requires support and action at the district, metropolitan and government level, and that individual communities may find that the main cause of poor water quality is due to upstream factors outside their immediate control. Communities should lobby assembly representatives and the EPA if this is the case.

At the community level, the following questions should be asked with respect to location of latrines, refuse dumps, communal bathing areas, car washing/repair areas and cemeteries:

- Where would runoff from the proposed site go?
- Would the runoff carry contaminated materials (water or sediment) into the vicinity of drinking water supplies?
- Would groundwater seepage contaminate borehole or well water?
- What might be the harmful by-products of the activity?
- Are there measures which can be taken to reduce the spread of contaminated water (for example, grass strips to encourage infiltration and slow runoff; contoured furrows to prevent runoff spreading contaminants; design of latrines and waste tips – lining to prevent deep seepage)?
- What is the best location for the activity to prevent spread of pollution? (location of latrines, for example, should be downstream of water supplies but at a site where waste will not be washed into the local stream)

Agriculture is traditionally located adjacent to rivers so that river water can be used for irrigation. Agriculture will reduce water quality, however, if excess fertiliser is applied or if soil erosion is triggered, leading to sediment load problems in streams. Prevention of erosion and measures to prevent large scale runoff into the stream are advised in order to reduce these risks.

A series of tables have been developed to explain how particular groups of people in the community can act to reduce pollution of the water bodies. These are presented here (Table 3.1, 3.2, 3.3, 3.4).

Table 3.1 Keeping Water Clean- What you can do when washing

Action Points	Bathing	Washing utensils	Washing clothes	Washing/repair of cars
What bad substances come from this activity?	Germs that give diarrhoea or typhoid	Germs Soap - phosphates	Germs Soap- phosphate	Soap/detergent – phosphate Oil, benzene
How can I avoid this bad effect?	1. Do not bathe in the river or near other water sources. 2. Bathe in an agreed location. 3. Build a soakaway for the dirty bathing water.	1. Make sure that used washing water runs into a gutter to a soakaway. 2. Do not wash directly in the stream. Use buckets of water.	1. Make sure that used washing water runs into a gutter to a soakaway. 2. Do not wash directly in the stream. Use containers of water.	1. Do not carry out this activity next to a river. 2. Build a earth bank or grass border around your work area to prevent oil/detergent being washed into a water-source in wet weather.
Are there areas where I should not do this activity?	1. Where dirty water will run straight into a river. 2. Upslope from a well or borehole.	1. Where dirty water will run straight into a river. 2. Upslope from a well or borehole.	1. Where dirty water will run straight into a river. 2. Upslope from a well or borehole.	1. On a river bank or at a river-road crossing. 2. Where oil can be washed downslope into a river. 3. Upslope or close to a well/borehole
Are there other things I can do to avoid dirty water from this activity hurting others?	1. Plant grass/low vegetation around/downslope from the soakaway or washing area. 2. If you wash your child after he/she has been to the toilet or has diarrhoea do this in the latrine area where there is a soakaway. Wash hands afterwards. 3. Do not allow children to play/wash near latrines.	1. If your water runs to a soakaway, check that it will not overflow in wet weather. If it does – plant grass downslope/around the soakaway.	1. If your water runs to a soakaway, check that it will not overflow in wet weather. If it does – plant grass downslope/around the soakaway.	Be aware that polluted water from your activities may flow downslope into rivers from which others drink or in which they wash.

Table 3.2 Keeping Water Clean: What the Community can do

Activities	Washing and Toilet	Garbage disposal	Cultivating the land
What bad substances come from this activity?	Bacteria, viruses and disease. Detergent, soap and phosphates. Nitrates and ammonia.	Detergents, bacteria, phosphates, nitrates, oils, metals.	Clearing the land can cause erosion of the soil during the wet season. Nitrates from fertiliser may enter rivers/water sources.
How can I avoid this bad effect?	1. Always use the latrine when you go to the toilet. Do not defecate in rivers or near water sources. Encourage your children to do likewise. 2. Do not wash yourself or your children near water sources. Try to use an agreed washroom/area if there is one in the village. 3. Wash your hands after going to the toilet. 4. Try to have an agreed area for washing clothes – away from water source vicinity.	1. Try to use a communal rubbish tip – do not let garbage accumulate around your house. 2. Try to sort your garbage and compost organics and recycle paper. 3. Do not throw batteries/similar items onto the land surface where dangerous chemicals might leak into local water. 4. Discuss with Unit Committee and Watsan members.	1. Locate your plot in a position to minimise runoff into the river when the land is bare/fallow. 2. Try not to cultivate right up to the river bank. 3. If your plot is near the river – have a vegetated border to reduce the amount of runoff draining from plot to river. 4. Do not cultivate immediately upslope of water sources. 5. Fill in gullies before they grow too big.
Are there areas where I should not do this activity?	1. On river banks. 2. Upslope from rivers or other water source. 3. In the vicinity of a borehole/hand dug well.	Do not locate garbage tips near or upslope from rivers, boreholes or wells. They should also be sited as far as possible from all water sources.	Depends whether you use large amount of fertiliser. If you do – see above.

Table 3.3 Keeping Water Clean- What builders can do

Activity	Clearing land	The building and its activities
What bad effects on water can come from this activity?	1. Clearing vegetation means that more rainfall can run off. 2. Run-off can erode the land. Erosion channels called rills and gullies remove the fertile top soil and send it into rivers. This can make the water turbid. The soil may also carry viruses, fertiliser or other pollutants which make river water dangerous for bathing and drinking.	1. Discuss the use of the building with Unit Committee and Watsan members. 2. Is the building use likely to result in pollution to local water supply? 3. Types of pollution: Latrines: Bacteria, nitrate, ammonia. Car Repair: Oil, benzenes, detergents. Wash room: Orthophosphates, bacteria.
Which are the areas where I should not build?	1. What is the building for? 2. Will it produce materials that damage the water (for example a latrine/wash area)? 3. Do not build latrines/washing huts or car repair huts near river banks if the run-off will directly enter the channel. 4. Avoid locations which feed into hollows or streams. 5. Avoid areas immediately upslope of boreholes/wells or rivers.	If the building is near a water source and might produce pollution: 1. Seek measures to prevent the pollution spreading such as a soakaway, vegetated strips to slow down runoff and allow water to percolate into the soil (except near a borehole). 2. Latrines – Ensure that the pits are cleared and do not overflow. If there is a danger of overflow – provide a gutter to route the overflow to soakaway. Likewise for washing areas. 3. If buildings are provided for toilets or washing – encourage all members of the community to make use of them.
What other actions should I take to keep the water safe for myself and others?	1. If the building is not a latrine/washroom – think about harvesting water from the roof (but wash the roof regularly and check that roofing materials are safe to use)	Keep gutters, soakaways or vegetated strips in good condition so that they do not fail in rainstorms.

Table 3.4 Keeping Water Clean- What the farmer can do

Activity	Cropping	Animals
What bad effects on water can come from this activity?	1. Fertilsers may be washed into rivers or other water sources during rainy season. 2. Nitrate pollution from fertilisers may make the water poisonous, especially for young babies. 3. Nitrates and phosphates from fertiliser may cause algae to grow in river water – killing fish and other river life.	Germs from animal faeces and animal urine can be a problem if animals are kept too close to wells/borehole surrounds.
Which are the areas where I should not farm?	1. Do not plant crops which need fertiliser right up to the river banks. 2. If you hoe your plot – hoe parallel to the river bank.	1. Fence off immediate area of boreholes and wells so that animals cannot defecate or urinate too close. This especially applies to upslope area. 2. Try to prevent animals trampling the soil close to water sources. This makes rainwater wash pollution into water sources more rapidly.
What other actions should I take to keep the water safe for myself and others?	1. Do not use too much fertiliser. 2. Add a grassed/vegetated border to you cropped field to reduce the amount of soil and fertiliser washed into the streams.	1. Always be aware of where water from your farmland might flow. 2. Remember that people downslope or downstream may be affected.

3.6 Waste Disposal Management

3.6.1 Methods of Waste Disposal

Open heaps
Open heaps may be suitable for small communities where waste generation is low. The site must be clearly demarcated away from any water body, public or residential buildings. Waste suitable for recycling and composting should be separated.

Small pits
Where the water table is low, pits may be created to receive refuse. The floor of the pit must be compacted with clay. This will prevent percolation of polluted fluids into the soil and therefore prevent ground water contamination. When it is full, dumping must cease, and the pit must be covered with soil to seal it.

Landfills
These are large scale refuse pits usually applicable for municipal and metropolitan areas. The floor of the pit must be compacted with clay to prevent seepage (leaching) of polluted fluids and therefore contamination of water bodies. Similarly, the side walls of the pit may also have to be stabilised against the escape of polluted fluids.

Ideally, after each day's activity, the refuse should be covered with a layer of clay soil. This minimises the incidence of foul smell, flies, insects, scavenger birds and also slows down the rate of harmful chemical reactions. It will also reduce the percolation of water during rains, and the movement of pollutants.

On decommissioning, the site should be spread with a sufficiently thick layer of soil to effectively seal the contents from interaction with the environment.

Incineration
Refuse may be burnt regularly or periodically. This reduces the extent of heaping, exposure and the attendant impacts on the environment. It also prevents fermentation and leachate formation in the refuse.

However, incineration often causes air pollution by producing smoke. The smoke contains particles that are not good for breathing. It also impairs visibility and produces gases that contribute to 'global warming'. Modern refuse usually contains many plastics, aerosol containers, and other artificial substances which when burnt, may produce harmful chemicals.

Incinerators must have very tall chimneys to distribute smoke and gases far beyond roofing levels. This dilutes the direct effects of gases and smoke particles on humans. Incinerators must also be sited away from water sources to prevent ash from being washed into the water. Ashes may also be cleared regularly from the incinerator to ensure its effective running. Ashes thus collected, may be treated as waste and dumped appropriately.

Composting
Composting, which can be considered as a form of recycling, makes available nutrients for soil replenishment.

Household waste can be composted. Organic refuse (for example waste food) kept in pits may be mixed with leaf cuttings, poultry waste, animal droppings etc. This can then be covered with soil to decompose it. The addition of water speeds the decomposition process.

3.6.2 Management of Waste Disposal Sites
Generally, waste disposal sites must be well demarcated and it is critical that children be discouraged from playing on or around the disposal site. The sites must be easily accessible and their paths always kept passable to encourage people to use them. It will also assist in controlled filling of the site. The usage must be backed by regulations and by-laws to ensure proper use of the facility, and to maintain cleanliness of the village environment. Where possible, the site should be overseen by an individual or group nominated or employed by the community or their representatives, e.g. via the WATSAN or Unit Committee.

Trees may be planted along the edges to mark the boundary of the area, and to reduce the visual impact of the site. Tree cover will also assist in the reduction of smell and insect infestations (see 'boundary planting' above).

It will greatly improve the management of waste disposal sites if garbage were sorted into categories before, or at the same time as, it is being dumped. Any materials which can be recycled should be sorted, for example metal, organic food and crop wastes (see *composting* above), paper, wood-cuttings and so on.

Periodic burning of the site will assist in reducing health hazards, and periodic levelling with soil is encouraged. Periodic inspection of the site by suitably-qualified personnel is recommended.

On decommissioning, asufficiently thick layer of soil should be spread over the area to seal it from the atmosphere.

3.6.3 The Way Forward: Recommendations

Six important measures to promote better waste management are recommended:

- environmental education to create awareness of the consequences of poor waste disposal
- proper selection of sanitary sites and encouragement of all members of the community to use them will help to safeguard against water pollution
- provision of the requisite sanitary facilities for communities
- regular collection of refuse and maintenance of public toilet facilities
- adding value to the refuse (e.g. composting)
- formulation of a system of community bye-laws (by the chiefs, elders and the community) to encourage better management practices

3.7 Some problems and considerations in the use of water harvesting

3.7.1 Water Quality

The community will need to consider the quality of collected rainfall. Two issues arise here, the immediate quality of the water; and deterioration that may occur if water is stored for a period of time. Rainwater collected from roof catchments will almost certainly be of superior quality to that collected from natural watercourses in peri-urban Kumasi. Communities should ensure that roof catchments are maintained in a clean state. Fallen tree branches and leaves, bird droppings, dead birds, insects or other contaminants may lead to deterioration in the quality of runoff unless the roof is checked/cleaned regularly.

Rainwater can itself be polluted by industrial emissions, although in lightly industrialised locations around Kumasi the risk is probably small.

Stored water must be covered to prevent contamination from unwashed hands. It can become contaminated with faecal bacteria from careless contact with unwashed hands, wind-blown dust or rubbish, or contamination from birds and other animals. Measures are also required to protect stored water from becoming a breeding ground for mosquitos. Mechanical methods include use of tight meshed materials to cover any openings in the tanks/cisterns.

3.7.2 Key design requirements for roof catchment systems

A simple roof catchment system is illustrated in Figure 3.14. The roof produces runoff which is collected in the sloping gutter. The gutter then channels the water into the storage reservoir. To optimise roof catchments, it is essential that the gutter 'harvests' the whole length of the roof. Contamination of the roof by bird droppings, dead animals or rusting metal (where corrugated zinc is used) must be avoided by regular maintenance.

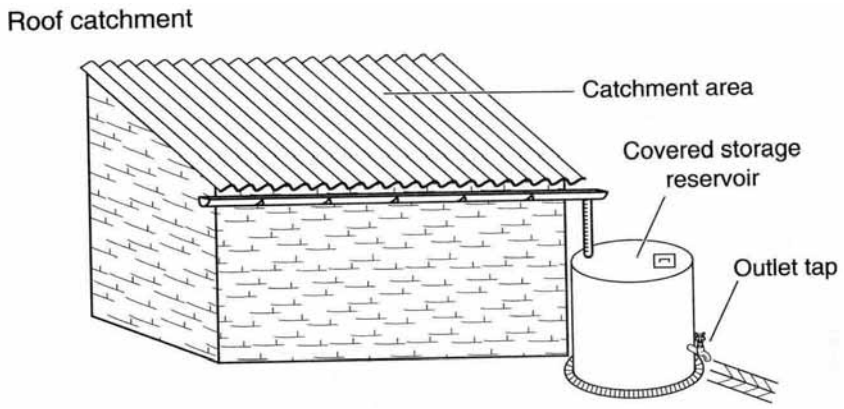


Figure 3.14: Roof catchment system.

Rules for the maintenance of roof catchments include:
1. Use of non-toxic, clean impervious roof materials (excluding lead, or materials painted with lead based paint, and asbestos-cement).

2. The surface of the roof should be smoothed by the removal of any vegetation. Overhanging tree branches should be removed to reduce contamination by leaf fall, bird excrement or animal access to the roof.

3. Taps in tanks should be at least 5cm above the tank floor to allow solids to settle undisturbed by drawing off water; and a means of flushing the tank of sediment should be provided.

4. A coarse filter should be used to intercept the water before it enters the tank, to prevent dirt entering the supply.

5. Wire/nylon mesh should be used on inlets to prevent insects, amphibians or reptiles entering the supply.

6. Measures should be taken to keep birds away from the roof catchment.

7. The storage tank should be light-proof (i.e. make from a material that does not transmit light, or else painted black) to prevent algae growth.

8. Tanks, gutters and roof surface should be inspected regularly.

9. Water from the tank should not be consumed directly without treatment for the first few days after a major rainstorm (though can still be used directly for washing and bathing).

Figure 3.15 shows a simple constructed catchment system for use when roofs or ground catchments are impractical. A wooden frame is constructed to provide a sloping aspect to the corrugated iron and a gutter is connected at the downslope end. The gutter should be sloping so that water is routed into the storage tank.

Purpose-built 40m^2 corrugated-iron 'roof' catchment from Botswana.
(Source: Pacey and Cullis, 1986, p.101)

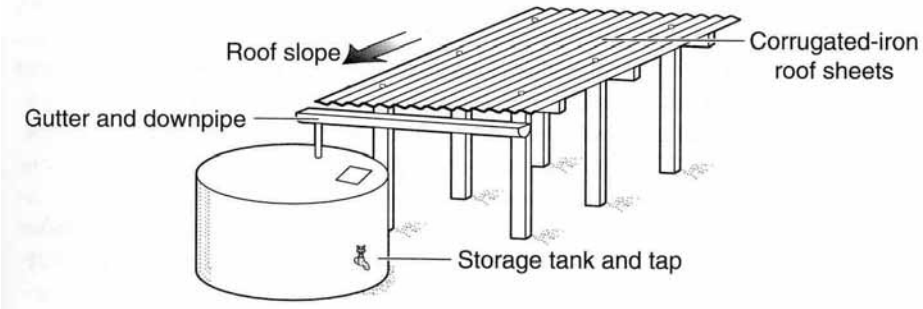


Figure 3.15: Simple artificial catchment constructed from corrugated 'zinc'

3.7.3 Controlling Mosquitoes and other Disease-carrying Insects

When constructing or repairing boreholes, hand-dug wells and water harvesting facilities (gutters and water storage tanks), it is important to minimise the opportunities for mosquitoes, and especially the malaria-carrying anopheles mosquitoes, from breeding. This species likes stagnant water in sunlight to lay its eggs. Wells and boreholes have been discovered to be important places for mosquitoes to breed and survive the dry season. The easiest ways to avoid this are:

- to provide shaded or darkened water storage facilities. Water storage tanks should be made of dark plastic or be painted black (this will also prevent algae from growing inside);
- to ensure that gutters drain properly and do not hold even small puddles of water (use of a soakaway is recommended);
- to ensure that wells and boreholes are kept clean and closed with an airtight lid or tap that does not allow sunlight to shine through. If possible, a cement or part-cement lining should be applied to the upper part of the well/borehole.

In addition, if you cultivate land in valley bottoms or other hollow areas of ground, it is important to avoid leaving stagnant pools of water for long periods of time. Where possible, leave natural vegetation, like grasses or ferns, around the borders of wetlands near rivers and other marshy ground. Their leaves help to keep sunlight off the water. Alternatively, by planting crops such as water-cocoyams right up to the edge of the water, the water will be shaded by their leaves.

3.8 Environmental Self-Monitoring

3.8.1 Water quality

The WATSAN should make a list of all sources of water for the community. The uses to which the water from each source is put, for example, drinking, washing, etc, should be considered. The most important sources will be those used for drinking water.

Agree a regular water source inspection. This will possibly involve an agreed team of villagers (perhaps including schoolchildren) visiting the water sources at regular intervals, say once per month. At each water source the following should be assessed:

Water Use

The level of pollution which is tolerable in a water source depends on the uses which are made of the water. Assess the use to which water from each source can be put:

- Domestic use: can the water be used around the home for washing utensils and clothes?
- Recreational use: can the river or pond be used for swimming without polluting downstream?
- Agricultural use: is the water source used for watering animals, and what effects will this have on downstream users?
- Human consumption: is the water used for drinking? In this case it must be of the highest quality possible.

Water Source Quality: Quick Assessments

- Water clarity: is the water cloudy? Are there foreign bodies in the water?
- Aquatic life: has there been a change in the number/type of water creatures present in the river?
- River site quality: is there rubbish near the river? Are people using the river as a toilet?
- River environment quality: are there activities taking place near the river which could contaminate the water (for example, car washing, rubbish dumping)?
- Does the river smell of sewage or are there any other strange smells near the water?
- River appearance: has the colour of the river water changed? Is foam or an oily film present on the water surface?
- Are there dead or dying fish present?
- Changes in water vegetation such as sudden increases of plants such as water hyacinth

Any dramatic changes in visible water quality should be investigated, and the source of the pollution identified and rectified. It this cannot be done, or if the pollution is due to a source outside the control of the community, then the community should seek outside assistance through the consultation mechanisms set out in Sections 5 and 6.

Water Quality Measurement

A more rigorous method of testing water quality has been piloted in five JSS schools, using Somerset Educational's *MicroChem Field Kit*. This field kit is available in Ghana through T-Mark Educational Services Ltd (see Directory) and comprises a wide range of tests of water conditions. The test kit allows you to tell whether a particular water quality indicator is Good, Probably OK or Bad. The JSSs at Ampabame No.1, Duase, Esereso, Maase and Sepetinpom have been using the MicroChem Test Kits, and contact regarding use of the kits could be made via the Head Teachers at these schools, or through the Ashanti Regional Office of the EPA.

WATSAN Committees might wish to consider whether a kit should be purchased for community use, though costs of the kit itself and the reagents required to maintain it should be carefully considered first. One (or more) member of the WATSAN Committee should be trained in the use of the kit, and should be given responsibility for regular testing of key weater resources. The EPA (see *Directory*) should be contacted for training in the use and maintenance of the MicroChem kits. If a decision is made to purchase a kit for community use, it is important that two issues should be borne in mind:

- use of the kit must be restricted to *trained* individuals
- maintenance of testing depends on spending money periodically (after purchase of the kit) on test reagents.

The kit provides quantitative measures of the following parameters:

- pH
- turbidity (cloudiness)
- water temperature

and a qualitative assessment of the following:

- coliform bacteria
- dissolved oxygen
- electrical conductivity
- nitrate
- nitrite
- orthophosphate

Table 3.5 shows the colour changes which are indicative of the status of water for particular pollutants or pollution indicators.

Pollution Indicator	**Good**	**Probably OK**	**Bad**
Dissolved Oxygen	orange colour	pink colour	no colour change
Microbiology	no colour change	some colour change	strong yellow colour
Electrical Conductivity	low light in sample	same level of light	stronger light
pH	6-8.9	4-5.9 or 9-10.9	<4 or >10.9
Nitrite	colourless	light pink colour	dark pink/red colour
Nitrate	colourless	light pink colour	dark pink/red colour
Orthophosphate	colourless	slight blue colour	stronger blue colour
Turbidity	all visible	2 and 3 visible	none visible
Water Temperature			

Table 3.5: MicroChem Field Kit colour changes for water quality

The significance of these types of pollutants and pollution indicators are outlined in Table 3.6.

It is important to emphasise that in general one or two indicators alone do not necessarily indicate that water is unsafe, but where most or all of the indicators are BAD, the water should not be used for drinking until EPA or GWC have been consulted.

Table 3.6: Types of Water Pollution Indicator and their significance

	Where does this pollution come from?	Why is it bad for me?	Can our Community help to reduce and prevent the pollution?	How does the pollution spread?	Can this pollution affect people downstream?	ACTION
1. Bacterial pollution	1. Dumping nightsoil or sewage in the river upstream of our village 2. Using rivers or river banks as toilets; poorly built pit toilets which leak onto the land surface or into the river. 3. Locating a latrine close to a river or borehole where sewage might leak across the land surface or leak into the soil around a borehole, hand-dug well or river. 4. Allowing animals to defecate near water sources.	Coliform bacteria and e-coli can cause gastro-enteritis, dysentery and other intestinal infections. Some of these can kill!	1. Encourage all people to use latrines. 2. Maintain latrines. 3. Make sure latrines are not located too close to, or upslope of rivers, boreholes or hand –dug wells. 4. Boil water if you are unsure it is safe. 5. Wash your hands when you have been to the toilet.	1. Water infected with faecal coliforms can spread downslope when it rains heavily. 2. Polluted water may soak through the soil into a well. Location explain??? 3. Poorly maintained latrines may attract flies which then land on food.	YES! If land is used as a toilet – rainfall washes the bacteria into the nearest river. If the towns or villages allow raw sewage into the river –it will eventually travel downstream and people may use the infected water for washing or even drinking!	1. If you think the pollution comes from another village or Kumasi – contact your local Unit Committee or Watsan representative.
2. Dissolved Oxygen level	1. Low dissolved oxygen can be caused by nitrate or orthophosphate pollution which causes tiny water algae to grow and use up the oxygen. 2. Most common sources of these substances are fertilisers, soap from washing in rivers, and sewage leaks 3. Animal faeces can also increase bacteria levels in the water which use up the oxygen.	Low dissolved oxygen levels may indicate that there are dangerous bacteria in the water. Low oxygen levels may kill fish and other water animals.	1. Do not use the river, or its banks as a toilet. 2. Do not wash cars near a river. 3. Do not wash yourself or clothes with soaps or detergents in/or near a river. 4. Try to avoid using large amounts of fertilisers on land that directly drains into a river or standing water.	The causes of low dissolved oxygen can spread over the land surface during rainstorms or leak through the soil. Soaps may be used directly in the water source. Fertilisers may be washed off the land.	YES!	Contact your Watsan or Unit Committee member if you think a factory may be causing pollution which damages the community water supply. EPA or GWC may also be helpful. Try to persuade people not to wash cars in the rivers.

Table 3.6: Types of Water Pollution Indicator and their significance

	Where does this pollution come from?	Why is it bad for me?	Can our Community help to reduce and prevent the pollution?	How does the pollution spread?	Can this pollution affect people downstream?	ACTION
3. Electrical Conductivity (EC)	High levels of EC come from fertilisers, factories and mines as well as naturally from groundwater which has dissolved salts from the local rocks or soil. High EC does not always indicate 'pollution' but may suggest the water is not good for drinking.	High salt contents in water can make it poisonous. The water may also kill plants if used to water them.	Try to ensure that large amounts of fertiliser are not used too close to river banks or near a well or borehole	Salts travel in solution with water over the land surface or through the soil.	YES!	Be careful! You need to ask GWC or EPA to check that the high EC is not due to the natural 'saltiness' of the local groundwater or river water.
4. pH	PH is a measure of how acid or alkaline your water is. Very acid or basic water can be dangerous to drink or swim in. Waste from factories or mines can be too acidic or alkaline. Acid conditions can be produced naturally from dead leaves and plants in the water.	Water which is very acidic or alkaline can irritate the skin and also be poisonous to drink.	Probably not: Most pollutants which cause acidic/alkaline water come from factories or where intensive car repairs or washing takes place. Rubbish tips may also leak highly acidic or alkaline material. Do not locate rubbish tips too close to streams or where water will easily drain into a stream	Acid/basic water will travel over the land surface and into rivers. It may also drain through the soil.	YES! – Where factories or other industry does not check the quality of wastes carefully. Where waste is dumped directly into a river or land contributing to a groundwater supply.	Try to make sure that decisions about location of rubbish tips take account of local drainage of surface water or groundwater. Contact Watsan or Unit Committee members if you are worried that a factory is discharging dangerous materials.

Table 3.6: Types of Water Pollution Indicator and their significance

Water test indicator of pollution	Where does this pollution come from?	Why is it bad for me?	Can our Community help to reduce and prevent the pollution?	How does the pollution spread?	Can this pollution affect people downstream?	ACTION
5. Nitrite and Nitrate	Application of fertilisers for crops or if many people urinate repeatedly near, or in, a water source.	High concentrations of nitrate or nitrite can be poisonous. They are especially dangerous to babies less than 3 months old. The sickness is called 'blue baby syndrome' and can prevent enough oxygen reaching the babies' organs. Nitrates also encourage algae to grow in water – some of these produce poisons and also reduce the ocygen content of the water , killing fish etc.	YES. 1. Discourage people from urinating in rivers or near to other water sources. 2..Encourage use of latrines. Make sure that latrines are properly built and located. 3.Do not let animal waste build up near rivers or other water sources. 4. Think about location of crops if fertiliser is to be used. Will the fertiliser be washed into the river? Maybe – relocate crops further from river banks or gullies? 5. Remember that if fertiliser is added to recently cleared land it will easily run into the river during rains.	1. Direct addition to rivers or water courses. 2. Washed from the land surface by rainfall and runoff. 3. Travels into groundwater by percolation. 4. Think carefully about location of fields when adding fertilisers. Will the fertiliser be washed into the river? 5. Do not use too much fertiliser.	YES! Avoid drinking contaminated water.	1. Discuss ways of preventing fertiliser draining into rivers/well sources with your Unit Committee or Watsan members. 2. Draw up a plan for avoiding fertiliser pollution. 3. Contact GWC or EPA if you think that a factory may be allowing dangerous wastes into the rivers.

Table 3.6: Types of Water Pollution Indicator and their Significance

Water test indicator of pollution	Where does this pollution come from?	Why is it bad for me?	Can our community help to reduce and prevent the pollution?	How does the pollution spread?	Can this pollution affect people downstream?	ACTION
6. Orthophosphate	Orthophosphates come from soaps and detergents as well as fertilisers. Washing people, cars or clothes in rivers or near water sources may pollute them. Leaking sewers may also be a source. Phosphate based crop fertilisers may be washed into water courses.	Orthophosphates are mainly a problem for other animals such as fish. Phosphates encourage water plant and blue-green algae growth. The algae can release poisons but the main effect if to reduce oxygen levels such that other water animals die.	Yes. Encourage people not to wash with soaps or detergents in local water courses. Washing cars near a river is also bad practice. Locate crops far enough from the river so that phosphate based fertiliser is not frequently washed into the stream.	By runoff across the land surface from fields during rainstorms. Direct addition of soaps or detergents to standing water or rivers. Some industrial waste dumpings. From rubbish tips – running into streams or leaching into groundwater.	YES – via rivers.	Discuss ways to prevent fertiliser draining from fields into rivers or other water sources with Unit Committee or Watsan members. Draw up a plan for avoiding fertiliser pollution. Contact GWC or EPA if you think that a factory may be allowing dangerous wastes into the rivers
7. Turbidity	High turbidity means that soil is getting into the river. This may come from erosion of fields and banks due to devegetation or overgrazing by animals.	Turbid water may contain bateria and viruses. It may also damage fish health by blocking their gills.	Try to prevent erosion of the land by repairing gullies, reducing devegetation on river banks and reducing the rate at which rainfall runs off by planting grass.	Spreads locally along river courses until the sediments settle out from the water and are deposited on banks or bed of the stream.	To a limited degree.	Not really a major issue.

3.8.2 Land degradation

As with water quality, it is important to monitor the condition of the land within and around the community. A group should be established (WATSAN members would be appropriate, but any group of concerned members of the community would be equally qualified (for example, farmers) to inspect the environment of the community on a regular basis (perhaps once every month). The group should walk around the community's land, and note any marked changes in status of the land.

A principal form of visual evidence of land degradation will be of increased soil erosion. Evidence of this includes:

- the appearance and enlargement of gullies
- progressive exposure of tree roots
- progressive washing out of fine materials on the slope
- progressive silting up of ditches and drains.

See Section 3.4 for some strategies for control of soil erosion. It is important to remember that soil erosion or gullies feeding into a water course may cause the more rapid spread of pollutants into the water. Soil erosion is therefore related to the maintenance of good water quality for the community.

3.9 Stakeholder Responsibilities

Stakeholder involvement: who and at what level? These questions will be answered in Section 5.

3.10 Consultation Mechanisms

Sections 5 and 6 contain information on who to consult for a particular problem, and how to go about this. Addresses and contact details for a range of organisations concerned with the environment are found in the Directory accompanying this Manual.

3.11 WATSAN handbook

Many of the problems and solutions discussed in this Manual are related to issues of water management and sanitation. Further advice is also found in the WATSAN Handbook produced by IGIP Consultants for the Community Water and Sanitation Agency (CWSA).

The Handbook covers:

- WATSAN setting up and organisation
- Water and hygiene: prevention of water-borne diseases and basic hygiene rules
- Water-borne diseases, and how to prevent spreading them
- Sanitation: basic sanitation rules and procedures
- Technical aspects of water source protection

Communities should use their copy of the WATSAN Handbook in conjunction with this Manual.

4. PRACTICE GUIDANCE NOTES FOR COMMUNITY MOBILISATION AND PARTICIPATORY NATURAL RESOURCE CO-MANAGEMENT

4.1 Community/Village

These terms are often used interchangeably; however they have distinct meanings that are often NOT synonymous:

A village is a physical entity; in rural and many peri-urban areas these are readily identifiable by the last dwelling and/or its lands.

A community is a social unit, involving a sense of identity and common membership. All residents in a particular village may constitute a community, but this is not always true:

- strong divisions may exist, in extreme cases giving rise to more than one distinct community in a village;
- non-residents (short and long term migrants) may still be considered community members, with attendant land and other rights and obligations;
- some residents may not be considered community members, e.g. 'stranger' groups of in-migrants, especially if living in a separate 'zongo' area.

In these notes, we use the expression 'village/community' to mean whichever of the terms is more relevant in any particular context.

4.2 Community homogeneity/heterogeneity

A common myth/misconception is that small communities, rural or peri-urban villages, and poor communities are largely homogeneous. Reality is often very different. Differentiation is common and may be quite wide, on the basis of:

ethnicity and/or religion
gender
age (intergenerational issues)
occupation/income status and the severity of poverty
political affiliation

All of these are relevant to the villages in peri-urban Kumasi.

4.3 Community Mobilisation

Responsibilities, Reporting, Record-keeping and Financial Security

- Wherever possible, avoid establishing a new committee within the villages for natural resource co-management, but utilise existing structures, especially the WATSAN or the Unit Committee (UC). Where these do not yet exist, or exist in name only, the most appropriate one may need to be established.
- Flexibility and appropriateness should be the objectives for whatever committees or other structures are established, enhanced or revitalised;
- A constitution or working arrangements for the committee covering e.g. powers and responsibilities; frequency of meetings; record-keeping and reporting/feedback procedures, must be agreed before it commences work In some cases, e.g. UCs and WATSANs, these duties and processes may be determined in whole or part by relevant legislation;
- It is important that the responsibilities and duties of each committee member (and especially the treasurer, secretary and/or chair) are clearly established and agreed, and this information widely known within each village/community;

- The division of responsibilities between each village/community and outside bodies to be engaged in co-management of the resource or facility should be set out and agreed in clear and unambiguous terms;
- In this context, it is vital that villages/communities are realistic and that they distinguish between causes/effects and problems/solutions/tasks that can reasonably be regarded as village/community responsibilities and those which necessarily lie beyond their control/resources;
- It will be important to emphasise repeatedly to the people in the villages/communities that the primary objective here is to promote their empowerment by facilitating co-responsibility for village and watershed natural resources, and their sustainable co-management with relevant outside bodies. If this is successful, each village/community should experience a tangible improvement to their quality of life through changes both within and beyond their village.
- Where funds have to be accounted for, collected and disbursed, it is essential that appropriate committee members be encouraged to occupy the positions referred to above, and that clear, transparent and agreed record-keeping and reporting procedures to the village/community are instituted.
- Funds should be deposited in a bank account and not kept in cash by the responsible person.

Implementation and Maintenance

Formulation of action plans, and any micro-project implementation, must be carefully appraised and scheduled.

In almost all cases, implementation will require an element of village/community co-funding or other contributions in terms of materials, labour, etc. These must be agreed and assured prior to starting implementation.

Actual implementation must be monitored to ensure consistency with the plans (subject to appropriate agreed changes during the process) and that it remains within budget.

A key part of the process is training, and the setting up of appropriate mechanisms for subsequent maintenance of the well, borehole, latrine, refuse site, etc. Sustainability depends on this. The community/village (through the designated individuals) must understand, agree to and accept their (part of the) responsibilities in terms of co-management. These are likely to include caretaking functions, mobilisation of labour inputs, regular collection of user charges or fees to cover repair and depreciation, and liaison with relevant bodies beyond the village/community.

In the case of fees or charges to be levied, the WATSAN, UC and ultimately village/community as a whole must discuss and agree on the level of such monies, and the basis for levying them. Community facilitators may need to provide guidance on matters such as:

the total amounts likely to be required over particular periods of time;
which mechanisms have been found to work successfully elsewhere; and
the importance of ensuring affordability to the poorest members,

as inputs to this process.

4.3.3 Externally Funded Microprojects

If/where microprojects are undertaken as part of the WMF with funds provided by external donors, extra care will need to be taken in managing them and ensuring transparency and accountability to those donors of the funds disbursed. Successful completion within budget (and on schedule) will be particularly important, as commercial donors want to maximise the publicity generated, including a prominent sign at the project site. They do not want to be associated with failure or incomplete projects, and almost certainly will not want to be involved in project planning and implementation. Local co-ordinators and facilitators will have special responsibilities in this regard. Procedures will need to include:

- competitive tendering for any significant commercial services e.g. borehole drilling;
- a formal contract with payment phased according to results or milestones, and penalty clauses;
- provision of references or details of completed projects that can be examined;
- opening a separate account code for each funder;
- progress reporting to the donor(s).

5. STAKEHOLDERS' ROLES AND RESPONSIBILITIES

This section outlines the most likely and important roles of each of the major stakeholders in order to illustrate how they should work together and integrate around a project or activity. However, it must be stressed that:

- each activity will involve a somewhat different set of stakeholders or actors;
- the precise combination and number involved will depend on the particular nature of each activity and its scale. Generally, the bigger the activity or project, and the larger the scale at which it needs to be addressed, the more stakeholders are likely to be – or need to be – involved;
- the list below (which is the same as listed in Section 1.3 above) is not totally exhaustive but is designed to illustrate the particular strengths and competencies of the major levels and groups of actors.
- new organisations are established and others close down, while periodic reorganisations of official structures may result in changing responsibilities among the various local, regional and national bodies. If liberalisation and privatisation policies continue, there may also be a change in the balance of roles and responsibilities between the state and private sectors.

5.1 Community

5.1.1 The Community at large

The Community at large is responsible for managing its own environment, taking into account the views and the needs of the whole community. This is especially important in the case of groups within the community which may have less access to facilities (such as the poorest members of the community) or may have particular roles and responsibilities within the community structure (for example women).

5.1.2 Schoolchildren

Pupils are the youth and the future. Changing their ideas and raising their awareness about environmental problems and what they can do to help is one of the most effective ways of influencing the wider community. This occurs through informing parents and other children in the family, and – indirectly – through parents hopefully changing their own behaviour out of shame or concern if they are not acting responsibly in relation to the environment when their own children are doing so. Schoolchildren can undertake activities which are both environmentally friendly and at the same time enhance their school learning experience, for example, through the use of the portable self-testing water quality monitoring kits linked to their science syllabus that have been used at Junior Secondary Schools within this DFID-funded project, or by undertaking collective action to combat erosion, collect litter, or tackle infestations of weeds or invasive alien plants on school grounds.

5.1.3 Parent-teachers' association

PTAs form a vital link between schoolchildren, their teachers, schools and wider community and can therefore play a very supportive role for their children by

- encouraging appropriate pupil activities when requested to do so by teachers,
- organising fundraising activities for school resources and activities,
- by encouraging teachers to undertake environmental activities with the pupils, and
- by turning out when possible to assist their children undertaking appropriate activities.

5.1.4 Teachers

Teachers can have a tremendously positive influence on their pupils' environmental awareness and actions, through teaching appropriate environmental responsibilities and the reasons for them, as well as by undertaking supportive activities like water testing in the community with the self-testing kits or environmental enhancement activities of the sort mentioned under 'schoolchildren' above. They should also reinforce such messages to parents and the wider community through the PTA, liaison with the chief and elders, Unit Committee and so forth.

5.1.5 Unit Committee

As the basic local governance structure, the Unit Committee is supposed to represent the community and to take charge of community activities. This includes the local environment, although the precise division of responsibilities between it and the community WATSAN varies among villages. The UC should support awareness-raising and practical activities to improve local environmental quality and resource management, through durbars, fundraising, communal labour and by making representations to the local chief and elders, and assemblyman/woman as appropriate, to address problems in their respective remits. The UC is a good example of grassroots level participation, complementing the role of the traditional authorities, which the community should use effectively.

5.1.6 WATSAN Committee

Each village should have a WATSAN Committee to take charge of water and sanitation matters. The effectiveness of the WATSAN is therefore central to environmental and natural resource management at the village scale. In principle, the WATSAN should be a subcommittee of the UC. However, the balance of responsibilities between the WATSAN and Unit Committee does vary considerably from village to village. The WATSAN should be actively involved in the improvement and management of village water supply (from wells or boreholes and/or rivers, as well as more innovative forms of communal water harvesting such as advocated in this WMF), toilets (whether traditional pit latrines, KVIPs or other facilities), and the control of rainfall runoff and the like. Ideally any facility requiring maintenance should have a designated person in charge, who is paid appropriately if necessary. A fund should be maintained from user charges or household levies in order to finance the upkeep and immediate repair of the facility. sAwareness-raising, organisation of communal labour for relevant activities, support of schools' initiatives, and liaison with the UC, chief and elders, and assemblyman/woman are also very important WATSAN responsibilities.

5.1.7 Chief and Elders

As the traditional authorities in each community, the chief and elders should support and encourage all environmental and natural resource activities to improve the state of the village and the quality of life of its members. In particular, they should support and liaise with the UC and WATSAN to ensure the effectivess of their respective roles. The calling of durbars, organisation of communal labour and fundraising activities, as well as liaison with the local assemblyman/woman, are particularly important. If the UC and/or WATSAN does not exist or is not functioning well, steps should be taken to facilitate these. If the chief is not resident in the village, a regent (*odikro*) or appropriate sub-chief should have explicit power to manage and make decisions in respect of these roles and responsibilities, so that prompt and efficient actions can be taken without the need to refer every issue to the absent chief.

5.1.8 Assemblyman/woman

It is the principal responsibility of the local assemblyman/woman to represent the village(s) in the District Assembly and to ensure that their interests receive due attention from the district authorities. Regular and effective liaison with the community or communities – and especially the UC(s) and WATSAN(s) – for which he/she has responsibility is therefore essential. Particular issues likely to be relevant here are the construction and maintenance of roads and other facilities and infrastructure, such as boreholes, pumps, culverts over streams, and refuse (garbage) removal.

5.1.9 Churches

Churches are a source of moral authority within many communities. They may support and encourage good environmental practice within the community through preaching and pastoral contacts with members of the community. They are also the sponsors of NGO activities and microprojects, for example CAFOD (Catholic Fund for Overseas Development), the Catholic Graduates Association and activities supported by the Methodist Church. The Churches may therefore provide encouragement, guidance and sources of funding for community environmental projects.

5.1.10 Polluters (other than 'normal' village/domestic activity)

It is the responsibility of every person or group undertaking activities which cause environmental disturbance or pollution to minimise the level and impact of that activity. The UC, WATSAN and chief and elders should exert all due pressure to ensure that this happens, and that appropriate measures are taken in consultation with these bodies to manage the pollution and to improve local environmental quality.

Persistent failure to remedy the problem should result in the imposition of fines or other appropriate measures, if necessary through liaison with the local assemblyman/woman, local authority, CWSA or Environmental Protection Agency (EPA).

5.2 Local Authorities

5.2.1 Area Councils

Area councils (Sub-Metropolitan Councils) within the KMA area are clusters of Unit Committees and have appointed officials. They are directly responsible to their District Assemblies and report to them on relevant matters.

5.2.2 Kumasi Metropolitan Assembly

Within metropolitan Kumasi, the KMA is the local authority. Some representative functions are vested in the sub-metro councils. The KMA is therefore responsible for many essential services relevant to the environment and natural resource management, especially refuse collection and sanitation, stormwater drainage, and planning functions such as land-use zoning, building plan approvals, building inspections, and traffic management. Refuse and sanitation services are dealt with by the Waste Management Department (WMD). The Department is charged with the provision of regular and effective services and has recently adopted a more customer-oriented mission statement to this effect. The new KMA Chief Executive is committed to turning over a new leaf. However, effective enforcement of many aspects of the Assembly's brief requires liaison with the EPA and with the four district assemblies which share boundaries with the KMA. This has been deficient in the recent past, giving rise to particular environmental problems along those common boundaries. Indeed, the KMA has often been cited by villagers and residents as one of the major sources of pollution through ineffective or inappropriate refuse and nightsoil dumping activities. These legacies are the responsibility of the new KMA and district assemblies to resolve in line with their mandates to serve their resident populations.

5.2.3 District Assemblies

The District Assemblies are responsible for the equivalent services and infrastructures within their respective boundaries. They have not always been effective in the past, and have a responsibility to improve services, and to liaise with neighbouring assemblies, including the KMA, in order to address cross-boundary issues and problems. They must also be responsive to representations from the assemblymen/women in respect of the needs and priorities of the communities within their boundaries. For matters requiring inputs from regional and national government, the KMA and district assemblies have the responsibility to represent their residents' interests to these higher levels of governance.

5.3 Regional and National Government

5.3.1 Regional Co-ordinating Council

The RCC is the body responsible for co-ordinating the work of the national sectoral (or 'line') ministries within Ashanti Region. As such, it fulfils a potentially vital role in ensuring intersectoral and interministerial harmonisation so as to maximise the benefits for the region. As such, this intermediate level of government must liaise both horizontally with the regional offices of relevant line ministries, and vertically, with the KMA and district assemblies within the region. The formal mechanism for doing this is through the district chief executives, who serve on the RCC along with some co-opted members.

5.3.2 Members of Parliament

Members of Parliament have a 'common fund' which is available to constituents to fund community projects.

5.4 Governmental Organisations and Agencies

5.4.1 GWC

The Ghana Water Company is responsible for the supply of safe drinking water through its network of pipes within urban areas. The company is a commercialised state-owned body, although partial or whole privatisation remains a possibility. The GWC's quality assurance department is based at its Suame office just beyond the Ring Road. The GWC is now working increasingly closely with the EPA's regional office in matters of joint interest and responsibility. The GWC also has an experienced borehole drilling team, that can be commissioned to undertake drilling on community or private land on payment of the appropriate charges.

5.4.2 CWSA

This government agency is charged with the provision of potable water supply to communities located where there is no piped water network. In other words, most peri-urban villages should use the CWSA as a key point of contact for evaluations of existing water supply, appraisals of the possibilities for constructing new wells or boreholes., or general water and sanitation hygiene awareness and training.

5.4.3 EPA

The main responsibilities and roles of this government agency are the enforcement of environmental legislation, undertaking environmental research, and the provision of advisory services to government. Its regional office is willing to accept enquiries and representations from individuals, community representatives and companies concerned about issues within the EPA's remit. It will, for example, undertake site visits to inspect suspected infringements of legislation, cases of pollution and so forth. For peri-urban communities, contact via the WATSAN or UC would be most appropriate.

5.4.4 Soil Research Institute of the CSIR

This specialised research institute has expertise in the analysis of soil characteristics and appropriate land-use options. All CSIR constituent bodies now actively encourage outside contract work on behalf of local communities. It should be contacted directly.

5.4.5 Village Infrastructure Project (VIP)

This nationwide project within the Ministry of Food and Agriculture is active in Ashanti Region, and can provide substantial funding for projects such as improved pit latrines. The VIP works closely with the CWSA in the selection of projects for implementation.

5.5 University Research Institutes

The various departments and more specialised research institutes like BIRD and IRNR at the Kwame Nkrumah University of Science and Technology, have expertise in important aspects of environmental resource management and rural development. They can be commissioned to undertake research, e.g. into water quality, agroforestry, conservation, socio-economic studies, and to advise on solutions to particular problems. They have a long record of collaborative work with local communities, NGOs and official agencies. These institutes should be approached directly.

5.6 Non-Governmental Organisations

NGOs like CEDEP, ISODEC, TREND, GOAN, or Friends of Rivers and Water Bodies can play a vital role in problem assessment, participatory local research, the provision of technical advice, liaison with official bodies or private companies, as well as project implementation and management. It is not appropriate to detail the different strengths and activities of each NGO here – such information is contained in the *Development-Environment Directory* produced and available as a separate resource (held at IRNR, KNUST).

6. GUIDELINES TO ASSIST COMMUNITY FUNDRAISING FOR MICROPROJECTS

6.1 Introduction

Wherever possible, communities should endeavour to undertake local environmental improvement and development projects themselves, using their own resources. This has several advantages:

- It ensures that the community has maximum control and involvement over the project and its implementation;
- It enables the community to commence and undertake the project as soon as it is ready;
- It will be attractive to government agencies and/or NGOs who are able to provide technical expertise and advice to the community (see the development-environment directory for potential sources of such expertise);
- It normally maximises the sense of collective achievement and should therefore enhance social capital (i.e. the strength of social cohesion through trust, mutual-help networks, etc);
- It should minimise the risk of local people ignoring or damaging the project after completion as a result of their sense of community 'ownership'.

However, in view of economic constraints and the levels of poverty in many parts of Kumasi and its surroundings, the resources needed for even a small microproject may simply not be available within the community concerned. As discussed with respect to agroforestry solutions and water harvesting options elsewhere in this document, there are some very basic no-cost or low-cost options available which could bear fruit.

Under these circumstances, it may be necessary to seek a donation or other funds in order to start or complete the project. This may not be easy, and will almost certainly take considerable effort and time to achieve. This frequently proves frustrating and may require several donors to be approached. It is therefore also very likely to delay implementation of the planned project.

Knowing whom to approach and how to do it are critical issues. Since individual villages and communities often lack the experience and knowledge to find these out for themselves, this section of the WMF is designed to provide guidelines on principles and procedures, as well as suggestions about the range of companies, NGOs, government departments and agencies which might be able to assist with expertise and finance. Further information and contact details for the respective bodies can be found in the Development-Environment Directory produced as part of this project. In other words, the Directory should be used alongside these guidelines.

6.2 Basic Principles and Guidelines

Before approaching any outside body for assistance, it is important for a community (or committee within a community) to be clear about what its aims and objectives are in respect of a particular problem or project. It is very difficult for an organisation to respond to vague, uncertain or irrelevant enquiries. The chances of obtaining such assistance will be far greater if the approach seems convincing and relevant to the organisation(s) concerned.

It may be difficult for a community or committee to know the most appropriate solution to a problem, and, indeed, there are several bodies capable of providing such advice and assisting the community to secure funding and a suitable contractor if these are needed.

These principles and guidelines have therefore been organised into groups that correspond roughly to the stages of activity needed to tackle a problem and undertake the resultant work.

6.2.1 Problem identification and strategy formulation

- If a problem emerges, consult within the community to find out whether all or most people agree that this is a problem and how serious it is.
- Ensure that the most appropriate committee(s) are informed and take up the case. For environmental and development issues, this is likely to be one or more of the WATSAN, the Unit Committee and/or Chief and Elders.
- The community or committee should then discuss and decide how to deal with the problem. Sometimes it can be addressed through internal measures. For example, if defecation by villagers in the bush is causing problems, the relevant committee should inform people about the health risks of doing this and could prohibit such behaviour. However, unless there are adequate and convenient latrines available, it is difficult to expect and enforce such a ban. Therefore, it may be important to provide latrines before banning open air defecation. Ordinary communal or domestic pit latrines could be dug by communal or household labour if soil and ground conditions are appropriate. However, if KVIPs are required, for example, outside expertise and funds may be needed.
- Decide on what resources exist locally for tackling the problem. If adequate skills, knowledge, labour and funds are available, it may be quickest and most efficient to go ahead without involving outside bodies.
- Even if outside help is needed, the community should decide what resources (including contributions of materials and labour) it is able to contribute. Increasingly, outside bodies, be they government agencies, NGOs or private companies, will be more willing to assist if they see that the community have thought about the issue and are prepared to make a contribution in cash or kind. This is known as 'co-financing', 'cost sharing' or 'participatory development'.
- Decide what outside help is required. Is it advisory/technical, or with actually carrying out the project, or is it financial, or is it more than one of these?
    - Advisory/technical advice may be needed if you have identified a problem but do not know how best to tackle it, or if you have decided what needs to be done but need specialised advice on the materials and procedures to follow.
    - For specialised jobs, like drilling and lining a tube-well, a suitably qualified and equipped contractor is likely to have to undertake the job; however, it may be necessary to obtain outside help to supervise and undertake parts of less specialised work if the skills are not available locally.
    - Financial assistance will need to be obtained if the cost of a project, e.g. drilling a borehole, is too high for a community to pay for entirely out of its own resources.
    - Sometimes, it is necessary to approach different organisations for each of these kinds of help, but some organisations will be able to provide more than one kind of assistance, and indeed, even to advise you on the best people to approach.

6.2.2 Approaching and negotiating with outside bodies

- Consult the *Development-Environment Directory* about appropriate bodies to approach for your particular needs (see also 6.2.4 below).
- If you have personal contacts within that organisation, or have dealt with them successfully before, it is probably good to make the first contact by telephone to ask whether that body might be willing to assist you. If the response is positive or neutral, the person you are in touch with will then suggest the best way to take things further. This is almost certain to be either by
    - writing a letter to explain your problem and/or planned project, and how you would like them to help, or by
    - arranging a meeting to visit the organisation for further discussions. A meeting is also likely as a follow-up to a letter, if they respond positively and see a reason to take matters further;
- If you do not have personal contacts or an existing working relationship, the best way to make the first contact will be by letter to explain your problem and/or planned project, and how you would like them to help. If they respond positively, they will invite further correspondence, or set up a meeting.

- If the response is negative, do not lose heart. It is not easy to obtain funds or assistance, and you should be prepared to contact several bodies following rejections or a lack of response from the first ones you try.
- Be polite, but do be prepared to follow up letters, phonecalls or meetings if you simply do not receive any response afterwards. The lack of a response may be because they are very busy or because they do not want to help you but are reluctant to say so directly. However, it is your right to expect a reply, so after a respectable period of time, do not be afraid to phone or write again.
- Be sure to explain how you have reached this situation, and why/how this help is needed, as well as what contribution the community or committee is able to make itself.
- The community or committee is likely to need a bank account in order to process financial transactions and to convince potential partners or contractors that you are serious and reliable, and to provide evidence that you have the required level of funds available. The WATSAN Committee will already have an account, otherwise opening a new account will be necessary. Compare the terms and services offered by competitive banks before signing up.
- If you will be paying for a contractor or technical advisor, you may be asked to pay in instalments during the programme of work. In such situations, make sure that the agreement states that you will pay only once you (or your technical advisors, as appropriate) are satisfied with the work.
- If you are obtaining donated funds to pay for a contractor's services e.g. to drill a well, the donor may well pay the contractor direct, with instalments agreed among the parties to coincide with particular phases of project implementation. In such cases, you should ensure that the funds are released only once you are satisfied with the work carried out in each phase.
- Verbal agreements are a traditional form of contract, but nowadays are usually inadequate as a form of security. It is necessary to obtain a written agreement or contract, setting out clearly the terms of such arrangements, including the sums of money involved, the work to be done by each party, and the timetable for undertaking and completion of the work. It is also helpful for a memorandum of agreement or a contract to be drawn up, covering the provision of materials and/or services, to include a clause setting out a procedure for resolving any conflicts or disagreements that might arise.
- When calculating project costs, the amount required as a donation, and/or drawing up a contract or agreement to cover the work, it is important to ensure that you are making provision for maintenance of the equipment or facility afterwards. Sometimes this is most appropriately done by the community or committee (e.g. by a designated person or by communal labour at specific intervals); but sometimes it may require donor funds and/or a commitment by a specialised contractor e.g. with respect to a tube well. For any facility that will need money to maintain, it is important to ensure that the funds are available. Experience has shown that the most appropriate method of doing this is by charging a small user fee (e.g. when using a KVIP or a handpump), with the funds going into a special bank account to cover maintenance and repairs.

6.2.3 Project implementation and maintenance

As with any project, it is important to be clear who is in charge of supervision, who has financial or technical responsibility, and who will be responsible for maintenance afterwards.

- Wherever possible, use an existing committee within the community for this purpose. For most development or environmental projects, this is likely to be the WATSAN or Unit Committee. The more committees there are within a small community, the greater the administrative burden and the more divided the energies and efforts are likely to be.
- The committee and individuals charged with particular responsibilities (if they are not already members of the committee) should meet regularly during project implementation to review progress, to take any appropriate steps needed, and to agree the release of payments to contractors and/or advisors.
- Take reasonable steps to avoid misuse – or even suspicions of possible misuse – of funds. Therefore, the lines of responsibility for each task or aspect of a project must be clearly defined and agreed;

- It is very important to record all such decisions through minutes of meetings. These, along with any correspondence, agreements and contracts, should be stored in a dry and safe place by the secretary or treasurer for future reference.
- For bank accounts, there should be at least two authorised signatories, with both signatures required for any payments.
- Agree the responsibilities and procedures for long term maintenance of the project – along the lines, for example, outlined in the final bullet point in Section 6.2.2 above.

6.2.4 Deciding which organisations to approach

There are many organisations in and around Kumasi, and some additional ones in Accra, with interests and expertise in the development-environment field. The Directory produced as another output of this Project provides an outline of the activities and interests of each, together with contact details (which were correct at the time of compilation). You should therefore refer to that in making your decisions.

The suggestions below are intended only as possible examples and relate to the more important ones for the major categories of development-environment problem and project likely to arise in urban and peri-urban Kumasi.

Water problems and solutions

- The Ghana Water Company (GWC) for problems relating to the supply of water within the Kumasi urban piped water network ;
- The Community Water and Sanitation Agency (CWSA) – for water problems, wells and borehole provision in rural areas and small towns.
- Various private drilling contractors for wells and boreholes
- The Environmental Protection Agency, Ashanti Regional office, for problems of water pollution and safety;

Refuse and nightsoil removal and disposal

- The Kumasi Metropolitan Assemby (KMA) Waste Management Department (WMD) within the KMA's area of jurisdiction
- Your local District Assemby in areas outside the KMA's boundaries
- The Environmental Protection Agency, Ashanti Regional office, for problems of unsanitory disposal, pollution and safety;

Pit Latrine construction

- CWSA
- NGOs such as Centre for the Development of People (CEDEP)
- EPA
- KMA Waste Management Department

General advice, technical expertise and microproject management

- NGOs like the Centre for the Development of People (CEDEP), the Integrated Social Development Centre (ISODEC), and Training, Research and Networking for Development (TREND)
- Bureau for Integrated Rural Development (BIRD), KNUST
- Soil Research Institute (SRI) of the CSIR

Organic farming and mulching methods

- Ghana Organic Agricultural Network (GOAN)

Agroforestry, rehabilitation of sand winning pits, revegetation, windbreaks etc.

- Institute of Renewable Natural Resources (IRNR), KNUST

Land law, land tenure and conflicts

- Institute of Land Management and Development (ILMAD), KNUST

The nation-wide **Village Infrastructure Project** is active in Ashanti Region, and can provide substantial funding for projects such as improved pit latrines. The VIP works closely with **CWSA** in the selection of projects for implementation. Individual communities can make representations to their District Assemblies, through their Assemblyman or Assemblywoman, for inclusion in the Programme; though a first step is to ensure that the community concerned is placed on the 'approved' list of communities eligible for assistance. This is done at regional level with the assistance of CWSA, by a survey of community populations and existing resources and infrastructure.

If successful, the community is obliged to provide 5 per cent of the capital costs of the project, with the District Assembly providing an further 5 per cent and the VIP funding the rest.

6.2.5 Considerations for Selection and Appraisal of Microprojects

For each micro-project, it would be helpful to build a profile with details against each of the following questions:

What is it?

How is it set up?

What are the set-up costs?

Who has primary role in implementation?

Who has primary role in monitoring its continuation/degree of success (where applicable)?

What are the running costs (where appropriate)?

What is/will be the outcome of the micro-project (what will it contribute)?

What funding model will be adopted?

Capital funding:

- stakeholders to contribute all or proportion of costs?
- institutional funding?
- shared or matching funding - local stakeholders/institutions

Running costs:

- subscription by users of facility
- 'in kind' labour for upkeep
- hire of labour (who pays, and how is money raised)
- institutional support

Which Institutions might be approached for financial contributions or assistance?

NB 'costs' include 'in kind' costs such as labour and other time (e.g. in monitoring and writing up any project results or statements).

7. THE ROLE OF THE KUMINFO GEOGRAPHICAL INFORMATION SYSTEM

The KUMINFO Geographical Information System was established in 1997 with UK Department for International Development funding at the Institute for Renewable Natural Resources (IRNR), KNUST, Kumasi, which provides air-conditioned premises and modest staff time.

KUMINFO is the central repository for data sets, map sources (other than the 1970s OS maps), 'modelling' the effects of environmental actions such as pollution, demonstrating the 'model catchment', and other activities carried out under DFID-sponsored research.

KUMINFO allows users to generate, interrogate and analyse map and output data related to Ghana in general and the Kumasi area in particular.

Geographical Information System (GIS) is a system of computer hardware, software, and procedures for the capture, storage, retrieval, analysis and dissemination of spatial data. Data in GIS are usually organised by the computer into 'layers' displaying different themes, which can be combined or overlaid to show the degree of agrrement between the selected themes.

7.1 What can KUMINFO do?

KUMINFO is intended to improve the efficiency of data gathering and to maximise the use of a wide variety of information available in a range of formats for the Kumasi region. KUMINFO provides a way of interpreting data for different map projections at national, regional, citywide and locality-specific scales. Facilities to construct a map, add new data to a map, query the data, construct new data sets and analyse results are all available within the system. Opportunities to combine datasets of different kinds add value to their interpretation and thus save time and money.

KUMINFO is updated regularly, with new census, survey and other relevant secondary and primary data. It is anticipated that organisations, which utilise the data sets within KUMINFO, will donate further datasets.

7.2 Outputs from KUMINFO

The data held in KUMINFO can be presented in many different ways, as maps, images, text files, tables, graphs, histograms and pie charts. These formats are all related and available directly within KUMINFO. A detailed knowledge of computers is not necessary to operate the system.

The KUMINFO office also acts as a resource centre to link particular problems with the means of dealing with them –
either by providing appropriate specialist advice
or by advising (through the Environment Directory) where specialist help may be obtained.

It also maintains an electronic bibliographic resource record of literature on Kumasi environments, and on similar situations elsewhere in the world.

7.3 Key personnel

The KUMINO unit is under the direction of Dr James Quashie-Sam, and the Data Manager is Ms Veronica Nana Ama Asare. The unit is located on the first floor of the main IRNR building, and Office Hours (which vary according to staff availability and time of the year) are posted on the door. An appointment can be made by telephoning (00233) (0)51 60375 or (00233) (0)51 60381. Dr Quashie-Sam's email address is: jqsirnr@hotmail.com.

7 Evaluation of Interventions Within the Project

This section reports on the evaluation activities undertaken in order to assess the effectiveness and impact of the Project's various interventions and dissemination activities. We focus in particular on the cartoon leaflet, the water testing kits, and the Water Management Framework and the associated micro-interventions undertaken as pilot demonstrations (tree planting, water harvesting, and erosion control). The evaluations formed an important component of the research, in that they were designed to gauge the perceptions of the communities with whom we have been working, about the interventions. In the context of the research focus of the NRSP as a whole, such feedback was required not just to ascertain the impact of this project but in order to evaluate the interventions and to learn from experience so that any relevant lessons could be applied in the Kumasi PUI and elsewhere in future. One element of the evaluations was to try to ascertain to what extent the responses reflected anything distinctive regarding the PUI as opposed to purely contextual circumstances.

7.1 EVALUATION AND ANALYSIS OF THE AWARENESS-RAISING LEAFLET 'WATER IS LIFE'

7.1.1 Introduction

This evaluation seeks to assess how the content of the leaflets (*Water Is Life, Conserve it!*) helped to inform the targeted communities in respect of water quality and its appropriate use. This research was completed over the period July-October 2001 as a result of discussions during the project's mid-term review, during which the need to undertake a formal evaluation of each separate intervention and dissemination activity was agreed. The specification for this evaluation appears in Appendix E. This evaluation took the form of interviews and discussions with the project leaders responsible for development and dissemination of the leaflets, and with representatives of the communities and organisations that received quantities of the leaflets.

The leaflets were distributed within the eight project villages of Asago, Adagya, Esereso, Abrepo, Atafua, Duase, Sepetinpom and Maase during visits by project staff. Leaflets were also disseminated at different workshops of this project (R7330) organised at the Kwame Nkrumah University of Science and Technology (KNUST) Campus in Kumasi in February 2000 and March 2001. During such workshops, leaflets were given to community representatives and participating NGOs to distribute them among the community members and to discuss the contents at community meetings. Project team members also disseminated some of the leaflets directly to community members.

GOAN, one of our Kumasi partner organisations, was so impressed by the leaflets that it requested a batch in each language to distribute among communities in Brong Ahafo and Eastern regions where GOAN were active on other projects. Our request for written feedback on how these leaflets were received and utilised has, unfortunately, not been met.

7.1.2 Awareness Creation

The villagers found it difficult to distinguish clearly between the respective impacts of the individual awareness-raising and dissemination activities associated with this Project, since the messages were being conveyed repeatedly during visits by project staff, as well as via the various activities and resources such as the leaflets. However, participants in the evaluation meetings in all villages involved in the research asserted that the communities *had* changed their ways of managing their environment to some extent. This phenomenon has created a cleaner and – for some villages like Maase and Adagya, where epidemics had been common – also a more healthy environment. Conversely, the impact in Esereso has been minimal, apparently because the community is experiencing a protracted chieftancy dispute which has weakened the power base of the Unit Committee and its ability to work effectively. Similar problems existed in Abrepo. However, the reactions from the other 6 villages were more positive.

7.1.3 Community Meetings

Some of the communities discussed the leaflets at village meetings, but others like Adagya, Atafua, Esereso and Abrepo did not hold any such community discussions on the leaflets. Adagya residents opined that they had not been requested to conduct any community discussion on the leaflets *per se*. There was a general feeling among the communities that project team members should have acted as facilitators for discussions of the leaflets and posters during community meetings at the time of their dissemination, so as to help them capture their significance fully. However, we had specifically decided not to facilitate actively, in order not to bias the process. Moreover, team members had already explained the objective of the leaflets at various junctures during earlier visits to the villages and junior secondary schools.

Most of the communities said that, as a result of the leaflets, there has been a change for the better in respect of environmental management.

7.1.4 Cartoon Leaflet

Colour and Size
Most of the communities appreciated the colour, cartoons and size of the leaflets, but Maase residents felt that any future leaflets should be in a new format with brighter colours so as to arouse the curiosity of community members.

Versions of Leaflets
Asago and Maase residents indicated that they were comfortable with the Twi version of the leaflets. Respondents in Adagya preferred the English version of the leaflet, whereas the rest of the communities were happy with both English and Twi versions.

7.1.5 Posters

All the communities requested larger posters in brighter colours to be posted at vantage points in their communities, which they believe would speak much louder to both the literate and illiterate. Had time and resources permitted, a desirable next step would have been to involve the communities in the development of the posters so as to create a sense of ownership of the research, thereby enhancing its prospects of sustainability.

7.1.6 Follow-Up

At the time when the leaflets were initially produced and distributed, there was no plan to undertake separate evaluations of each document or intervention. The intention was to obtain a perspective on the cumulative impact of these activities together, since respondents are often unable to distinguish so clearly between the impact of several related small activities. Hence, no clear records were kept of the numbers of leaflets given out to the respective organisations and communities. This limited our subsequent ability to relate responses to the numbers distributed in each case.

Some of the community leaders in Adagya, Atafua and Esereso kept the leaflets to themselves and failed to distribute and discuss it with other community members, as intended and as we had specifically requested. Nevertheless, community members in these villages claim success in how they are managing their environment, but – as elsewhere – this success may be due to their ongoing interaction with project staff and pieces of advice offered to the communities at different times, since the leaflets were not made public by community leaders.

7.1.7 GOAN

GOAN were so impressed by the leaflet when used at Duase that they requested a further batch to distribute among their organic farming groups in several other regions of Ghana where GOAN conducts other projects and demonstrations:

- Dadieso and Enchi in Western Region
- Amponsahkrom near Wenchi in Brong Ahafo Region
- Gyasi Camp near Adukrom in Eastern Region, and
- Twifo Agona and Praso in Central Region

They disseminated the leaflets alongside their own materials. Unfortunately, however, due to staff changes and pressures, records of the numbers actually distributed in the different locations, how they were disseminated and what impact they had, were not kept or reported to Head Office.

Even since the end of R7330, GOAN have failed to submit their final report on their activities for the project, including the leaflet distribution, despite repeated requests from our local co-ordinator.

7.1.8 CEDEP

With the departure of Mrs. Victoria Kumi-Wood, who was in charge of the publication of the leaflets, it has become difficult to ascertain whether, and how many, leaflets were left with CEDEP for distribution. Much effort has been made to get in touch with her but to no avail. This is particularly unfortunate because the Twi language version was produced with the principal intent of using them in adult literacy clubs run by or affiliated to CEDEP. The idea was to use them as an adult awareness-raising tool simultaneously with language learning. In the event, the main literacy club, situated at Anloga, ceased to function shortly after the leaflets were produced, thus frustrating the plan.

Moreover, the original plates of the leaflets had gone missing from CEDEP's Publications Unit, despite a specific instruction to retain them for possible future use. This precluded rapid production of additional copies for dissemination at the end of the project, as intended. Consequently, photocopies were made from surviving examples of the leaflets.

7.1.9 Final Follow-up

In January 2002, approximately 200 remaining leaflets were distributed to participants in the evaluation meetings in the eight villages. These were to be followed up during March 2002. However, despite explicit instructions to that effect, no record was kept of where and to whom they were distributed, thus making detailed evaluation impossible.

7.2 OVERVIEW OF THE SURVEY ON WATER TESTING KITS CONDUCTED IN JUNE/JULY 2001

7.2.1 Introduction

The water testing kit experiment involved five selected junior secondary schools (JSS) in or near villages where the project's other research was being undertaken. Our objectives were:

- To involve schoolchildren and their science teachers in community-based environmental monitoring;
- Thereby to promote awareness of the problems and issues – and hopefully then behavioural change – amongst the children and indirectly also their families;
- To enhance the children's school experience by providing relevant, 'real world' practical experiments linked to their syllabus but which they would not have had the equipment or resources to do without our project;
- To augment the scientifically collected and analysed water data from GWC and EPA through more frequent and 'low-tech' monitoring;
- To enable us to compare the results obtained from the simple water test kits in 'lay' hands with the scientific data.

The prior approval of the headteachers and science teachers concerned was obtained. In each school, the team, comprising one or more of the science teachers and a group of pupils selected by them, conducted water quality tests at approximately monthly intervals, using portable test kits supplied by the project. These had been obtained from Somerset Educational in South Africa, where they had been used successfully in similar circumstances by Umgeni Water (Hill, Nel and Papalouzia 1997; Nel and Hill 1997). The schools began testing water in September 1999. Prior to commencement, members of the project team provided a training session covering the aims and objectives, issues involved, and use of the kits. A set of technical guidance notes was subsequently provided and the Environmental Protection Agency undertook regular visits to the schools during their own water sample collection trips. These visits provided advice, back-up and replenishment of chemicals for the test kits.

The precise method of dissemination to non-participant pupils and the wider community was left to the discretion of the respective headteachers and science teachers. However, the objective was to see the extent to which this experiment sensitised each community to the extent of local water quality problems and therefore the need to change unhealthy habits which were contributing to poor health and sanitation.

Based on the above, a survey was conducted within the following schools and communities; Maase community and JSS; Asago community and Ampabame I JSS; Duase community and JSS and Esereso JSS to ascertain how the project had been faring, and whether the outcome of the water quality testing had been reaching the targeted people. Problems relating to staff turnover at Sepetinpom JSS apparently precluded such an evaluation at that time (see below). The survey was conducted within the months of June and July 2001.

7.2.2 Methodology

Structured questionnaires were used to establish what was happening in the project communities in respect of the water-testing project (Appendix F). The focus group discussion method was adopted in order to elicit the perception of various groups within the communities about the ongoing project, and the extent to which the communities had changed their attitudes towards water and river bodies.

Further, group discussions based on the questionnaires were also employed to get information from the communities. This method was used as a means of triangulating information gathered during focus discussions.

Table 7.2.1 Groups with whom the interviews were conducted

COMMUNITY	GROUPS INTERVIEWED	NUMBER OF GROUPS	TEACHERS INTERVIEWED
Maase	Schoolchildren, teachers, head teacher, Chief and elders, Unit Committees, cross section of women with two men.	Six groups	1. Akwasi Kyei Nti – Transferred 2. Coffie Stephen 3. Kwakye Evans 4. Nimako Samuel
Asaago/ Ampabame	Schoolchildren, teachers, head teacher, Chief and elders, Unit Committees and cross section of women with two men.	Six groups	1. Kusi Poku Brobbey, 2. Paul Dabanka 3. Nicolas Adofo 4. Anthony K. Akom
Esereso	Head teacher, Teachers and pupils	Three groups	1. Anarfi Stephen 2. Arthur James 3. Radeska Eguakum 4. Jocelyn Kuffour
Duase	Head Teacher, teachers, pupils, Chief and Elders, Unit Committee and a group of women.	Six Groups	1. Ernest Abu Sakyi – Admitted to Cape Coast University 2. Kormododa Moses 3. Nat Annan Nunoo

The interviews were conducted during June and July 2001. Some communities had to be visited more than three times, hence the specific dates on which the interviews were conducted are not included. It proved impossible to carry out the planned interview at Sepetinpom at that time.

7.2.3 Issues Arising

The following issues emerged from the survey:

Pupil Involvement

With the exception of Esereso JSS, it was reported that relatively few pupils per school were directly involved in the water testing itself, though water samples were brought in by other pupils and, in some cases, concerned adults from within the community. At Esereso, the teachers centrally involved had designed the collection and analysis to involve pupils from all classes, thus ensuring that even the youngest pupils had a role to play.

At Sepetinpom and Ampabame No.1, selection of team members by the science teachers was restricted to the final year class, and in general schools reported having selected the brightest or most enthusiastic pupils. Selection of final year pupils had the disadvantage that continuity was lost to an extent when that class graduated, as the younger pupils were less familiar with the water-testing project. However, one important reason underlying this restriction was that the test kit was the only piece of scientific equipment present in several of these schools. It was reported by some children that the pupils who were selected were more spectators than active participants, although it is not recorded as to whether these were the comments of pupils who had been 'selected' or not.

Involvement of Teachers

From the survey, it was reported that in two schools (Maase JSS and Ampabame No.1) only one teacher was centrally involved in the water-testing, and in both those schools the headteachers took an active interest in the experiment. Elsewhere, groups of teachers took an active interest, and assisted the science teacher in managing the experiment. Some teachers reported a lack of concern about the

project, giving the reason that they had not been invited to participate. Staff changes inevitably caused some dislocations in activities, especially at Sepetinpom JSS, where all three teachers involved left at the end of the same academic year, and the new teacher, though enthusiastic and supported by a senior teacher, took some time to pick up the experiment.

The Outcome of Water Testing

It was reported by some respondents that the water test results were not always made accessible to other teachers or the pupils who did not take part in the exercise, thereby leaving them very poorly informed so far as the project is concerned. In such cases, the children claimed not to have any information to relay to their parents at home. It was claimed that only the few pupils involved in the testing exercise had the opportunity to tell their parents about the outcome of the water tests they had conducted.

Nevertheless, most schools did perform one or more plays (sketches) and/or poetry readings for the whole community at a public meeting (durbar) since mid-2000 to reflect their water testing work and the resultant messages for the communities. These durbars formed an important part of the dissemination process (see above). The chief (*odikro*) presided and in several cases reinforced the message by invoking the villagers to take heed. The durbars had a major impact and became a talking point, both on account of the high quality performances put on by the pupils and because of the alarming picture painted of water bodies in the various communities.

Regular visits by Project staff to the villages also contributed to awareness in the wider communities about the Project through focus group discussions, other meetings and casual conversations during the course of project activities.

Furthermore, all the schools were invited to each of the three annual Project workshops held at IRNR. In each case, representatives of the participating pupils were explicitly included in the invitations. All of the participating schools did bring pupils along. In the final workshop, the schools also made a presentation to a plenary session. In this way, the schools were linked up to the wider work of the Project and given the opportunity to interact with all other participants. Feedback and dissemination within their schools and communities should thereby have been greatly enhanced.

Effects of Water Testing on the Communities

Although it appears that some communities had not received much specific information from the school, those people within the communities who had heard and witnessed the drama productions staged by the pupils to illustrate the environmental situation in their communities claim to have changed their attitudes in respect of water usage and how they generally treat water in their communities. The general impression was given, and the claim repeatedly made during our evaluations, that dumping of both solid and liquid waste in the rivers, washing of dirty clothes and other unhygienic acts had been reduced since the Project started.

The following specific examples of behavioural change were cited: washing of vehicles in rivers at Esereso and Duase has since apparently been reduced to a minimum; as has swimming in the streams by the children; and even the Fetish Priestess at Maase has stopped performing rituals in the Asuo Abena stream. The same community claims now to engage in a 'scoop-up' (desilting) exercise when the stream becomes very muddy.

Sustainability of the Water Testing Project

Prospects for more positive change will be enhanced if there is a regular flow of information from the schools on the outcome of the ongoing water testing to the communities. We have encouraged the schools to continue after the Project ends, and to which end we have supplied the EPA from Project funds with some stocks of chemical reagents for the test kits and a small contribution to other costs.

Clearly, there are doubts about the sustainability of the initiative, both in terms of continuation finance and technical support. However, EPA has taken up an active role in this. It is envisaged that if the schools are able to launch the planned environmental clubs, and the EPA staff are able to continue their

regular visits, then the experiment is likely to be sustained. In this respect, CEDEP is interested in involving the clubs in its Youth Initiatives Programmes.

Kit Usage

A mixed message emerged from this part of the evaluation. When the pupils were asked about how comfortable they felt using the water test kits, they were not able to articulate particularly convincing responses. This does suggest that some of the pupils were spectators of the testing process and did not have the opportunity to participate actively in the process. On the other hand, the enthusiasm shown by those pupils attending the Project workshops and participating in the durbars suggests that many did gain the appropriate knowledge and experience. However, in some cases, it may well be that the initial class in 1999/2000 was more enthusiastically involved than subsequent cohorts.

Control of the Environment

Almost all the communities agreed that they alone cannot address the problems of water quality, and that the Kumasi Metropolitan Assembly (KMA) and district assemblies (DAs) should involve themselves in the effort to combat pollution in the water bodies and the environment in general. This relates to other aspects of the work of this Project, as reported elsewhere.

7.2.4 EPA's Perspective

The EPA staff who liaise with the communities confirmed that during the inception of the water testing project, two or three teachers were selected for the project in each school but that subsequently the lead teacher was sometimes left to shoulder the responsibility of conducting the water testing with the pupils. In some cases, for example Sepetinpom, as explained above, staff turnover exacerbated the problem.

Given the level of support provided and the ongoing contact with all the schools, the EPA staff were surprised to hear that the children interviewed had been unable to respond to some of the questions convincingly. They suggested that this may reflect the method of interview used and the way in which questions had been posed. On the contrary, they reported ongoing enthusiasm and interest within the schools, both from teachers and participating pupils.

7.2.5 Reflections and Recommendations

- At Maase and Sepetinpom selection was made from the final year class and after their graduation the remaining pupils were less familiar with the water-testing project. It is therefore recommended that, in future, selection of pupils to form the teams for water testing should be from the two most senior classes so as to provide greater continuity for such a project.

- It was observed that none of the schools had been able to incorporate the water testing into their syllabus and timetable as originally envisaged (and despite demonstration by Project staff or the relevance and usefulness of the tests in a number of areas within the JSS science syllabus). It is recommended that the head teachers should be encouraged to assist other teachers to draw up a timetable in respect of the use of the water testing equipment for more of the classes so as to facilitate discussions on the subject under consideration during lessons. This could include use of the test kits for related activities, such as measuring chemical reactions, alkalinity and acidity, electrical conductivity or tests for fertiliser residues. Resource, of course, is the major stumbling block in this regard.

- If proposals put by the Project grantholders to the EPA Head Office come to fruition, such water testing can be promoted nationally, in which case it would be linked centrally to the syllabus through the Education Ministry. This would embed such monitoring in a way that a small project like this simply cannot achieve.

- It is clear that the absence of environmental clubs in the schools will not help the sustainability of a project such as this. Establishment of clubs would be a step in the right direction, since both EPA and CEDEP have interests in this, and as CEDEP has a Unit for such youth groups. It would be

laudable to embrace these youth clubs and strengthen them so as to sustain the process that has been set in motion by the Project.

- The resources we have left with the EPA should help sustain the water testing beyond the end of this Project. With encouragement from the respective authorities, teachers and *odikros*, the test results should be made available to the communities more regularly. This would remind the communities of the impact of their activities in respect of environmental management.

- It should be remembered that this was very much an experiment, with a perspective of 'try it and see what happens'. Although general discussions on sampling and dissemination procedures were held with participating teachers, the teachers were not directed towards particular pupil selection, water sampling, analysis or dissemination strategies. Lessons can be drawn from the way in which the experiment panned out, but this should in no way detract from the awareness that has been created, with admittedly differing degrees of effectiveness, amongst teachers, pupils and their communities.

- In conclusion, the water-testing project has certainly had an impact in various ways. The central purpose of raising awareness has been achieved at all levels of participation or observation. Although it could be said that the regular testing has not always involved as many staff and pupils as envisaged, and the schools have not always communicated as regularly with their communities at large as hoped, it must be remembered that this was left to those actually carrying out the experiment, and no pressure to 'perform' (either in the figurative or literal senses) was put on those taking part. The information that did reach the communities has clearly helped to shape their perception with regard to good environmental practices. It is anticipated that if information flows from the schools to the communities were strengthened, a high degree of a positive change in target communities could be achieved through the use of these water quality test kits.

7.3 ASSESSMENT OF THE WMF ON BENEFICIARY COMMUNITIES IN KUMASI PERI-URBAN AREAS

7.3.1 Introduction

Four successive rounds of evaluation interviews were undertaken at approximately two-month intervals, in August/September and November 2001 and January and March 2002. This research design was intended to

- assess whether, and to what extent, perceptions and behaviour in relation to the environment within the eight study villages were changing as the project progressed and different activities and microprojects were implemented;
- ascertain whether there were any particular problems pertaining to project activities that we could address during the remaining life of the project.

The evaluations were undertaken principally by Bright Asare Boadi, Sampson Edusah and Vesta Adu-Gyamfi, with specific occasional inputs from other team members as indicated below, while David Simon joined the team for two meetings during his visit to Kumasi in January 2002.

Since the principal focus varied from round to round, slightly different methodologies were adopted by the team, as summarised below. While some issues were raised in successive evaluation rounds, it is noticeable that the final summative evaluations in March 2002 reported far more positive perceptions of the project's activities and their impact.

7.3.2 Methodology

August/September 2001: Perceptions of Village Groups

The first round of evaluations centred on perceptions among different groups within each village community regarding current environmental problems and potential steps to address them. This was, in effect, a follow-up to the in-depth surveys undertaken during the first phase of this project, during which perceptions and priorities for action were identified in 1999 and 2000. These priorities included modest interventions by the communities themselves and by outside agencies; some of the latter reflected a widely held belief that this project had substantial funds available for such work, despite regular explanations by team members that this was not the case.

The evaluations were undertaken by means of group discussions held with chiefs and elders, women, farmers and youth, on the basis of who turned up to the previously arranged meetings, and also follow-up meetings as necessary if attendance at the original meeting was not sufficiently representative, e.g. with respect to inclusion of the poorest segments of the community.

November 2001: Evaluation Report of Microprojects in Communities

The objective of undertaking microprojects under the WMF was initially motivated by two factors:

- The idea of modest interventions in line with priorities identified by each village (Table 7.3.1), that could be implemented at least partly by villagers, in order to raise awareness, stimulate communal activity and hence hopefully maximise the prospects for longer term involvement and maintenance. Observing the process of implementation and subsequent use and management would provide a valuable element of this project's research.
- The need to allay people's frustrations by providing villagers with rapid and tangible benefits after several years of research by successive NRSP and other projects.

Table 7.3.1 Matrix of locally perceived village problems and possible priority actions, 1999/2000

Village	Inadequate potable water		Inadequate toilets and sanitation		Poorly sited or maintained waste dump		Soil erosion in village		Sand/gravel winning pits		Institutional/committee weaknesses		Water course encroached/ polluted
	Serious Problem	Action Planned	Serious Problem	Action Planned	Serious Problem	Action Planned	Serious Problem	Action Planned	Serious Problem	Action Planned	Serious Problem	Action Planned	Serious Problem
Maase	Moderate √	Hand dug well							√√	Rehab = vegetation + OF			√
Sepe tinpom			Especially in Zongo	Maybe new KVIPs	Especially in Zongo	Tackle littering							√
Duase	Irregular pipe flow	Discuss with GWC; pass hand dug well		Assist completion of new KVIP if still pending	√	Tackle KMA		Tackle gullying + sheet erosion					
Adagya								Tackle gullying + sheet erosion	√√	Tackle: finish rehabilitation + veg + OF		Liaise locally; Help establish WATSAN	√
Atafua							√√		√√	Rehabilitation = Vegetation + OF		Try to involve assemblyman	√
Abrepo			√√	Improve maintenance or relocate	√√	Improve clearance and maintenance or relocate		Tackle erosion + drainage				Try to reconcile chief with UC + assemblyman	√
Asago	√√	Borehole (co-funded)						Tackle erosion + drainage					√√
Esereso					√√Too close to river and houses	Relocate dump			√√	Rehabilitation + OF if not to be used for housing			√

Key

OF = organic mulching and planting methods NB: micro-enterprise tree nursery in Esereso needs markets: we should buy saplings/seedlings there for planting in other villages

Sustained efforts to obtain support from large industrial firms in Kumasi ultimately proved unsuccessful, despite agreement reached with the managing director of one firm. As a result, the project decided to fund very small microprojects (tree planting for vegetative screening, water harvesting and erosion control) in the communities, depending on their needs and priorities. This had the object of demonstrating a selection of best practices in watershed management and small interventions that communities can undertake themselves, at little or no financial cost, to improve their environmental management and hence environmental quality at the watershed level. The process of implementation and maintenance would be carefully monitored and evaluated as part of our research programme.

After considerable discussions between the UK and Ghanaian collaborators and the communities, implementation started in August with the tree planting at Adagya. Dr Quashie-Sam led the tree planting and installation of water harvesting equipment, while Dr Nsiah Gyabaah was given responsibility for the soil erosion control. The project was implemented in August and September 2001 (Tables 7.3.2 and 7.3.3). Dr. Sampson Edusah, Bright Asare Boadi and Vesta Adu-Gyamfi carried out the initial round of evaluations of the micro-projects from 5th to 26th November 2001.

January 2002: Evaluation of the Watershed Management Framework (WMF) – (tree planting, rain water harvest and soil erosion control)

This exercise was conducted from 15th to 26th January 2002 by Sampson Edusah (SE) and Vesta Adu-Gyamfi (VAG). An interview checklist drafted by Duncan McGregor and developed further by SE was used as a guide for the evaluation (Appendix F). All eight participating villages were covered. Dates of visits and attendance at each village are as in Table 7.3.4:

Table 7.3.2 Tree planting – Agroforestry

First visit	Village Community	*Contact persons*	Date of supply	Date planting completed	comments	Type /numberof seedlings				
						Gliricidia	Cassia	Prekese	Teak	avenue
10/08	Adagya	**Chief and Abusuapanyin**	**16/08**	**08/09**	**Community participation very good**	**60**	**40**	**30**	**0**	**70**
15/08	Esereso	**Kwarteng Safo Adu Kofi Anane**	**16/08**	**07/09**	**Community not interested**	**40**	**60**	**40**	**50**	**10**
15/08	Sepetinpom	**Asamoah AnokyeFrimpong Chief**	**16/08**	**13/09**	**School children planted**	**40**	**40**	**20**	**40**	**60**
15/08	Duase	**Yaw Andrews Chief /elders PTA Chairman**	**16/08**	**21/09**	**Children carried seedlings hired labour planted**	**30**	**50**	**30**	**40**	**50**
27/08	Abrepo	**Auntie Attaa Agya Oppong Kwaku Owusu**	**10/09**	**15/09**	**hired labour planted**	**30**	**50**	**30**	**50**	**40**
29/08	Atafua	**Auntie Martha Appiah**	**10/09**	**15/09**	**Community not quite interested**	**30**	**30**	**20**	**80**	**40**
30/08	Maase	**Simon Owusu and Organiser**	**10/09**	**18/09**	**Community participation very good**	**20**	**40**	**30**	**50**	**60**
31/08	Asago	**Appiah and Agya Dapaa**	**10/09**	**14/09**	**Community participation very good**	**40**	**50**	**30**	**30**	**50**

Table 7.3.2 cont.

Village Community	**Comments**
Adagya	**Seedlings planted as avenue on compounds with community participation**
Esereso	**Planted at refuse , compound and latrine Community not so interested**
Sepetinpom	**P;anted at JSS compound and latrine**
Duase	**Avenue at JSS compound and at Primary school**
Abrepo	**Refuse dump latrine and Burial place**
Atafua	**Latrine and refuse dump**
Maase	**Avenue at funeral grounds and Latrine**
Asago	**Refuse dump and compound**

Table 7.3.3 Water Harvesting Installations

Date of 1st visit	**Village/ community**	**Location of installation**	**Contact person**	**Date installed**	**Remarks**
27/08	**Adagya**	**Chief's palace**	**Chief**	**05/09**	**Functions well whole household very happy**
27/08	**Adagya**	**Abusuapanyin's house**	**Abusuapanyin**	**05/09**	**Functions well whole household very happy**
27/08	**Esereso**	**JSS building**	**Headmaster**	**06/09**	**Works well students happy nearest water source far**
30/08	**Asago**	**Primary School**	**Chief**	**11/09**	**Functions well want more tanks**
30/08	**Ampabame**	**JSS building**	**Head teacher**	**11/09**	**Functions well entire school was full of praise**
03/09	**Duase**	**JSS building**	**Headmistress**	**13/09**	**Functions well**
03/09	**Sepetinpom**	**JSS building**	**Headmistress**	**13/09**	**Functions well**
04/09	**Abrepo**	**Primary School**	**Headmaster**	**17/09**	**Functions well. Additional one needed for nearby JSS**
04/09	**Atafua**	**Abusuapanyin's house**	**Martha**	**17/09**	**There is a problem with the slope. An additional gutter required to change direction of flow.**
06/09	**Maase**	**JSS building**	**headmaster**	**18/09**	**Functions well**

Table 7.3.4 Interview schedule

No	Village	Date	Attendance		
			Male	Female	Total
1	Esereso	15 – 01 –02	5	26	31
2	Atafua	16 – 01 - 02	13	13	26
3	Abrepo	18 – 01 - 02	11	28	38
4	Duase	20 – 01 - 02	18	28	46
5	Maase	22 – 01- 02	54	44	98
6	Adagya	23 – 01 -02	30	20	50
7	Sepetinpom	23 – 01 -02	-	-	-
8	Asago	27 – 01 - 02	30	22	52

The meetings were pre-arranged some days ahead of the meeting day. On the appointed day, the team, comprising SE, VAG and the video cameraman, visited the community well ahead of time for the people to be organised. After exchange of greetings and other pleasantries, the team went round to inspect the trees, rain harvest facilities and the soil erosion control. The cameraman covered these rounds. After the rounds the people gathered at their usual meeting grounds for the evaluation led by SE.

It can be noted from tables 7.3.2 and 7.3.3 that these interventions had been well received on the whole. Simone minor teething problems were reported and acted upon. Some seedlings had not survived due to dry weather and insufficient watering, while sacks for soil erosion control had not as yet been provided in some villages.

March 2002: Final Summative Evaluation of the Entire Project and its Activities

This final round of evaluations within project R7330 sought to investigate the impact of the research on the eight project communities. The evaluation is on technologies such as, erosion control, water harvesting system, tree planting and good environmental practices in general as promoted by the Project activities.

The evaluation was carried out between 17th and 26th March 2002 by the three-member team of SE, VAG and Bright Arare Boadi (BAB). BAB and SE first visited and prearranged the meetings with the communities.

Getting community members to attend the interview was a big problem. Most of the people were not available for discussions; those who were available were not willing to meet us. This was particularly the case among the youth. This may stem from the fact that the communities appear tired of the research team. The communities involved in this research project included, Maase, Duase, Abrepo, Atafua, Sepetinpom, Esereso, Adagya and Asago.

The team adopted the question and answer method to collect the necessary data from the communities. Those who responded to the call for the meeting were met as a group. They included the young people, the elderly, men and women. Efforts were made to give each individual the opportunity to respond to the questions. SE and BAB did the questioning while VAG took down the responses and other comments**.**

7.3.3 General Comments on November 2001 Evaluations

After the initial delays, the implementation of micro-projects started in August with tree planting in all the eight villages. In communities such as Adagya, Asago and Maase the trees have established quite well. Protection of the young trees is generally poor in all the communities. It was clear that the involvement of the people at Atafua, Abrepo and Esereso was poor as a result either some of the seedlings have been left unplanted or there is little protection provided for the ones planted. Asago is the only village in which the community has planted additional trees since the seedlings supplied to them. It is, however, anticipated that when the trees grow into maturity, the people will see the benefit in tree planting and plant more in the communities.

Water harvesting facilities have been supplied to seven of the eight communities, mainly at the JSSs or other suitable buildings facilities. For Abrepo, facilities had yet to be installed. This has been brought to the attention of Dr Quashie-Sam. The impact of the water harvesting would be expected to be felt better in communities such as Adagya and Asago where there are no pipe-borne water facilities. Even here, it had been noted by villagers that the impact is reduced due to the small capacity of the reservoirs. It was learnt that the water collected was finished in no time, although it was emphasised that this was, in effect, a demonstration of potential rather than an attempt to meet demand. The anticipation is that the people would find the system useful and the cheapest means of providing reasonable quality water in their homes. Again, it had been emphasised that this water could be used for general domestic purposes, apart from drinking and cooking.

In some villages, the soil erosion project had been slow to start, since the communities claimed not to have received training in how to use the empty sacks supplied to them. On the other hand, the villagers of Maase and Duase had implemented the experiment enthusiastically, and in Maase in particular the utility of the sacks had already been demonstrated with the early rains. In Asago also, the villagers had emplaced filled sacks in a significant gully at the side of the main road in the village.

7.3.4 General Comments on January 2002 Evaluation

General observations made during the evaluation of the projects are as follows:

It was noted that communities like Adagya, Asago, Maase and Duase have better understanding of the objectives and are more involved in the protects than communities like Sepetinpom, Abrepo, Esereso and Atafua. The reasons may be:

- The chiefs of Adagya, Asago, Maase and Duase have taken personal interest in the project
- The Unit Committees are better organized in Adagya, Asago, Maase and Duase
- Organization and mobilization of people are easier in the small peri-urban communities than in the larger peri-urban villages
- The heterogeneous nature of the larger peri-urban communities makes people apathetic to communal work.
- There is poor communication between the Unit Committee members in the larger peri-urban communities than is found in the smaller peri-urban villages.
- Villages (Sepetinpom, Abrepo, Esereso and Atafua) with strong urban influence have performed rather less well on the programme particularly with the tree planting.
- The timing of the planting of the trees was not ideal as it coincided with the dry season which – coupled with inadequate watering by the villagers – has resulted in the death of many trees.
- The IRNR Technician did not make any follow-up visit after the supply of the seedlings.

7.3.5 General Overview of the March 2002 Evaluation

Despite sustained efforts by the Project team to explain the project's purpose and the difference between research and technical co-operation, the communities seem not to understand this distinction fully. They still criticise the research for not doing much for them in respect of providing tangible infrastructure like potable water, latrines and a health facility.

In spite of this unfulfilled potential, the people spoken to said that the research project has impacted positively on their lives. It was reported that they have generally become aware of certain practices which are highly damaging to the environment. As a result, they are now admonishing people against such practices.

Maase praised the project in respect of erosion control methods that have been provided to the community. They said that the timely intervention of this erosion control methodology will help them to combat the serious land degradation problem they were facing as a result of run-off whenever it rains. Residents of Asago had also filled the sacks and placed them in appropriate locations but felt that they would need more in order to tackle their problems effectively. We therefore repeated the explanation that this was merely a demonstration that they should take up and expand themselves. Unfortunately, the curiosity of the children of Duase prompted them to break the sacks to see the contents. None of the communities mentioned the possible use of cover crops as a means of checking erosion.

The eight project communities were very much interested in the tree planting exercise embarked upon by the project. They were highly optimistic that when the trees grow up the skylines of their communities are going to change for the better. They were of the view that the trees would protect their communities from rainstorms, thereby sparing them from disaster that other communities are experiencing. The trees would serve as filter on foul air emitting from refuse dumps and latrines. Furthermore, the trees would serve an

ornamental function in the eight project communities. In other words, they were concerned with aesthetic as well as practical considerations.

The water harvesting experiment had probably aroused the most enthusiasm, with numerous requests from villagers for an installation. The existing installations were not without problems, and further advice on cleaning the tanks and protecting the water from contamination was given. There had been a number of instances of water being drawn clandestinely from the tanks at night which, although reprehensible, is an indication of impact! Headmasters and teachers were enthusiastic at the opportunity for better washing facilities, though it had to be restated that the water should be used for washing rather than for drinking. However, there were a number of comments to the effect that the water collected was perceived to be of better quality than that from other sources such as rivers and some hand dug wells.

Duase and Asago were enthused about the relocation of Kumasi Metropolitan Assembly's refuse site and the apparently imminent cessation of faecal tipping at Kaase, respectively, as these had been located close to their communities. They attributed their greater will to confront the situation to the enhanced awareness created in them by the Project, although the Project cannot claim direct responsibility for the relocations.

Several communities agreed that refuse dump-related diseases had dwindled due to appropriate locations of refuse dumps. Maase community held the view that an epidemic, which hitherto has been an annual ritual, is no more a threat to the community since they relocated their dump on the advice of the research team. Adagya community also inferred that the refuse dump situated in the immediate front view of the community has been removed as a result of the team's constant advice on the need to relocate the refuse dump. Conversely, Atafua community said that in spite of the educational campaign on the need to manage refuse separate from water bodies, the people of Abrepokese continue to dump refuse in Ntikyei River, which is a tributary of the Owabi River.

On the whole, in spite of the fact that the project was not a form of technical co-operation to supply infrastructure, the communities felt that the research project has really impacted positively on them thereby leading to environmental awareness on the part of the people of participating communities.

8. Conclusions

8.1 ORIENTATION AND PRINCIPAL ACTIVITIES

This Project has taken forward research on the Kumasi PUI under the NRSP, building upon the foundations laid by projects R6448 and R6799, in particular, by focusing attention on a more holistic approach to natural resource management at the watershed scale. This has entailed working with a wide range of stakeholders, from villagers and peri-urban micro-enterprise operators to the respective local and regional authorities, parastatal corporations, official agencies and urban industries with activities affecting, or responsibilities pertaining to, the PUI. Close liaison was also ensured with project R7995, which ran parallel with the final year of this Project, through the involvement of David Simon and James Quashie-Sam as a subcontractor and local collaborator respectively on the latter. This had a particular benefit in terms of the use of CLFs trained by R7995 in the final few months of this Project (see below).

Although the project remit required us to minimise the amount of new primary data collection by collating and integrating existing material from the predecessor projects as far as possible, we rapidly identified and proceeded to fill several important gaps in relation to knowledge about current natural resource use and management, and environmental quality. The most important of these gaps related to:

- the extent and precise nature of water quality and pollution in peri-urban areas, including the contribution of different sources and types of pollutant to the overall load
- the natural resource-based and other activities of urban industries and peri-urban micro-enterprises that might impact upon peri-urban environmental quality
- current natural resource use and environmental management practices by peri-urban communities
- the diverse nature of livelihoods – especially in relation to natural resource use – of people in villages experiencing different degrees of urbanisation-driven pressures in the PUI, and how these livelihoods and conditions in the villages have changed over the last decade and a half
- the generally low levels of awareness among all stakeholders about the state of the peri-urban environment and the exploitation of natural resources, and ways to raise the profile of such issues, including the extent to which schoolchildren could be motivated to disseminate environmental messages within their communities
- the perceptions and priorities of peri-urban villagers, in particular, in relation to current NR use and environmental conditions, and potential improvements thereto, including their willingness and ability to adopt low- or no-cost strategies to address NR problems
- the extent to which the KMA and four surrounding District Assemblies were engaging with Local Agenda 21 processes, either autonomously or through linkages with ICLEI, and what impact these might have on sustainable development in the PUI.

Given the size, shifting boundaries and rapidly changing nature of the PUI, the methodology adopted, following an initial reconnaissance during the Inception Phase, was to concentrate our attention on a representative sample of watersheds and village communities within them. Accordingly, we identified that part of the Owabi catchment feeding the Owabi Dam, and the Sisa-Oda catchment as appropriate examples of the 'inner zone' of the PUI where the impacts of rapid urbanisation are most pronounced. These watersheds were used for water quality monitoring along transects that covered the changes in stream/river conditions as the water approaches, then flows through and out of the urban area (Sections 3.5, 3.6 and 3.13). For reasons of practicability and in order to facilitate integration of different aspects of the research, the water sampling points were selected close to the sample of eight villages chosen to represent the spectrum of conditions in the PUI. These range from essentially urban in the cases of Abrepo and Sepetinpom to predominantly rural in the cases of Adagya and Asago. Only two of these villages (Duase and Asago) had been included in the databases compiled by project R6448 and R6799; accordingly, we had to undertake baseline surveys in them all in order to ensure a common database and to update earlier material where it was available (Sections 3.7 and 3.13). Indeed, on the basis of the range of conditions we

encountered, we found it most useful to conceptualise the inner part of the PUI as part of the functional urban area rather than as an entirely separate zone (Section 2.1).

The outputs from our new primary research have been reported in detail in Section 4 of this report. These data represent an important resource in themselves, not least as substantial contributions to new knowledge about Kumasi's PUI. For instance, we collected probably the most detailed time-series of data on urban and peri-urban water quality in Ghana, the first systematic attempt to assess the contributions of urban industries and peri-urban micro-enterprises there to pollution and NR exploitation in the PUI, and the first detailed analysis of the levels of awareness among villagers and other stakeholders of the nature and extent of the problems, and of appropriate methods to address them. Importantly, however, this was not research for its own sake, but vital information for the more applied central project purpose of incorporating this new knowledge into peri-urban planning and management strategies. Hence, all the research findings contributed towards the participatory process of raising local awareness of existing problems and of possible ameliorative actions and solutions by various stakeholders.

8.2 ADDRESSING COMMUNITY PRIORITIES: RESEARCH VERSUS TECHNICAL ASSISTANCE

Since this has been a research rather than a technical assistance project, large-scale remedial or even preventative work on the ground was beyond its scope. We initially intended to concentrate on

- raising awareness of existing problems through participatory methods such as the use of basic water testing kits by junior secondary school pupils (Section 4.8), and through local radio broadcasts and the production of widely distributed leaflets, and
- bringing the various stakeholders together to discuss these problems and to explore ways forward, by means of community meetings, focus group and round table discussions, as well as annual workshops with associated field visits to familiarise stakeholders with the variety of conditions in the PUI and to see activities promoted by the project
- facilitating self-help and mutual help, through the compilation of resources such as a *Directory of Development and Environmental Organisations and Institutions in and around Kumasi*, and an annotated Bibliography of relevant materials (Appendices G and H respectively) and through the production of guidelines for community-based diagnosis of problems and appropriate actions to address them, i.e. the Water Management Framework (Section 6)
- finding some appropriate mechanism for demonstrating these principles and remedial actions to villagers and other stakeholders, in the manner of pilot or demonstration projects.

In the event, it rapidly became clear that one consequence of NRSP's strategy of concentrating its West African research projects in Kumasi and its PUI has been progressive 'research fatigue' among communities that have been repeatedly studied. Although basically supportive, they were – quite understandably – becoming increasingly frustrated at having to answer similar questions time and again, albeit sometimes in participatory mode, for and with the staff of successive research projects. When, they demanded to know – occasionally with considerable anger – were they going to see some practical action to address their problems? In more than one case, it was made clear to both our local and UK-based team members that they would not be welcome unless to offer some concrete benefit to the villages concerned.

This found resonance with the Project team's desire to find appropriate means of demonstrating 'good practice' and enabled the extension of the research in an innovative direction. This was to study the communities' responses to, and adoption of, a series of experimental interventions designed as participatory demonstration microprojects in line with the priorities expressed in each village during the participatory VCS/WVCS processes. These small and inexpensive interventions had the objective of showing what each household and community could do themselves to address problems and ameliorate conditions at little or no financial cost. The top priority in most villages was to obtain an additional source of potable drinking water. In line with the project's ethos, we felt that the process of construction by the community of hand-dug wells or the installation of a borehole, and the establishment of an appropriate management and maintenance mechanism by villagers would be worthy subjects of research.

Such projects required resourcing beyond the financial means of this Project, but we felt them worthwhile if such funds could be secured, in order to be able to demonstrate a wider range of scales and types of microproject than would otherwise have been possible. In fact, sustained efforts by Project members to leverage funds for the boreholes and wells from Ghanaian corporate donors were ultimately unsuccessful. Hence we focused on the smaller and cheaper interventions that had originally been envisaged. Various water harvesting techniques were used to demonstrated the procurement of a supplementary source of additional water. The next highest priorities expressed by villagers, namely provision of trees and bushes to screen refuse tips, provide shade and fruit; and erosion control measures, were also addressed. This multi-stranded strategy gained ready approval from the villages and ensured continued collaboration. In practice, levels of participation and enthusiasm regarding the demonstration projects varied, and results therefore ranged from excellent to mixed (see below).

In keeping with 'best practice' in development work, our strategy for engagement with communities was based on the principle of working with and through the most appropriate existing village institution or committee, rather than establishing a new one. Our inception studies had shown quite clearly that a small core of involved people tended to be active in a multitude of local fora and the establishment of a new structure would only add to their loads without necessarily engaging a wider range of people. In particular, the WATSANs and Unit Committees have terms of reference directly relevant to the work of this Project, and – along with the chiefs/*odikros* – they became the focus of our community liaison. This principle is also fundamental to the proposals in the Water Management Framework (WMF) comprising Section 6. Where WATSANs did not exist or were inactive, we sought – ultimately without success – to galvanise them.

This, along with the presence or absence of at least one 'champion' (who was willing to be proactive) on a committee, and the problem of over-research discussed above, explains much of the diversity of response within the sample of eight villages. Overall, the most visible impacts and greatest levels of enthusiasm were found in Adagya and Asago and Maase. In the final months of the project, we were fortunately able to draw on the Community Level Facilitators (CLFs) identified and trained by Project R7995 as part of its task of preparing participatory and sustainable NR-based livelihood strategies in villages, including all those within this Project. Atafua had initially responded very poorly, but the role of a dynamic CLF there stimulated greater interest during the final months of the project. This example underscores the value of having appropriate and enthusiastic community members with specific responsibilities 'on board' and able to galvanise people proactively on a daily basis. In many cases, the CLFs had been selected by the communities; a few had been nominated by chiefs.

8.3 CHANGES TO ACTIVITIES DURING THE PROJECT'S LIFE

The implications of three other changes during the Project to our originally conceived research activities warrant mention:

- the need to maintain the KUMINFO GIS for the duration of the Project; its funding came to an end with the completion of Project R6799 in 2000; accordingly we were awarded a supplementary grant to maintain and develop KUMINFO until the end of this Project and to help the IRNR to formulate and implement a business plan to become self-sustaining by that time. It also enabled us to utilise KUMINFO for additional research purposes. Occasional outside research work has been undertaken; diverse maps for sale or use by other research projects have been produced; undergraduate GIS courses have been introduced at IRNR; and the business plan has been compiled. However, market research and marketing are behind schedule and the system is not yet financially self-sustaining (Section 5).
- the change to DFID's – and hence the NRSP's – mission statements to make poverty reduction the principal objective. Although our work schedule was already well advanced, we were able to modify our later activities to some extent in order to focus more on the poor, and especially to seek to ensure that they were included explicitly in the participatory demonstrations and WMF process. This focus is also being carried forward in terms of the livelihood plans formulated and targeted in project R7995 and its successor, R8090.

- the importance attached by the NRSP management to evaluation of each activity and intervention, which emerged through the Mid-Term Review process, necessitated an extension to the planned evaluation activities in order to attempt assessments of the leaflet and radio broadcasts, as well as the more sustained activities of schools' water testing and the demonstration projects within the WMF (Section 6).

8.4 PRINCIPAL FINDINGS AND CONCLUSIONS, AND THE CONTRIBUTION OF THE OUTPUTS TO THE PROJECT AND NRSP PURPOSES

This Project was not designed to contribute directly to achievement of the NRSP's goal of improving livelihoods through sustainably enhanced production and productivity of RNR systems, and is therefore unlikely to have a direct impact on peri-urban livelihoods, especially those of poor people. However, it has certainly contributed to the achievement of the NRSP purpose by applying new knowledge to natural resources management in PU production systems. More directly, the Project has achieved its own purpose of *identifying the impacts of urban growth on land use patterns and natural resources degradation and incorporating this into strategies for PU planning and management* in many ways, through

- the integration of existing data and knowledge about Kumasi's PUI
- the generation of substantial new knowledge about the set of issues and processes identified in Section 8.1 and about the practices and perceptions and reactions to participatory interventions by villagers and other stakeholders, as summarised in Section 8.2.
- the raising of awareness about environmental and natural resource problems among stakeholders, especially villagers, and with attention to the particular position of the poor
- research into the responses to, and uptake of, selected micro-project interventions in PU villages designed to promote participatory and sustainable co-management of resources
- the identification and incorporation into the WMF and via the demonstration microprojects as strategies for peri-urban planning and management, of the impacts of urban growth on land use patterns and natural resources degradation

This Project has attained those parts of its purpose that lie within the team's power. The WMF and its constituent components have been formulated and discussed within workshop focus groups and with individuals from the respective local authorities and planning departments, as well as the eight villages. The assumption about political will was partially invalid prior to the general election of December 2000; following the change of government, the situation improved but progress has been slow. The OVI and MOV of take-up and implementation by the policy bodies have therefore not yet been achieved as stated.

The remainder of this section outlines the principal findings and conclusions, which reflect the OVIs and MOVs at the output and activity levels. We are pleased to report that the Project has been successful in achieving virtually all of its OVIs, albeit in some cases not by the precise dates anticipated. The only OVIs not yet achieved are those that fall beyond the power of the Project to ensure, namely the uptake of all the project outputs by policy bodies (Activity 3C.1 and 3C.2). However, even here there has been partial success to date, through the extensive consultation with and demonstration activities for representatives of the diverse set of official and NGO bodies concerned with the PUI. These include the Regional Co-ordinating Council, Kumasi Metropolitan Assembly, District Assemblies, CWSA and others. Awareness has been raised, liaisons and in some cases (e.g. GWC and EPA) collaborative work undertaken for the first time as a direct result of this Project's activities. The important assumption 3C.1 has been partially valid, especially since the change in political climate since the December 2000 general election. However, the reorganisation and personnel changes in regional and local authorities as a result of the change in government continued through most of 2001, making it difficult to galvanise rapid action in response to the work of this Project, although the response to our contacts and liaison activities was generally more positive. Provided that our local partners are able to maintain some contact and provide some encouragement in the period following the conclusion of this Project, we are hopeful that the WMF will still be taken up and sustained.

8.4.1 Water and environmental quality

A two-year monitoring record of water quality undertaken by the Project in a range of situations in the peri-urban interface, both upstream and downstream of the city, indicates clearly the extent and nature of pollution (Section 4.7). These monthly data have been supplemented by short-term investigations of pollution 'hot spots'. Together, these datasets provide clear evidence of progressively increasing pollution from the relatively unpolluted headwaters through the city and back into the peri-urban zone to the south of Kumasi. Coliform bacterial counts rise rapidly downstream from the headwaters, indicating ubiquitous contamination of the streams and rivers by human excrement.

Specific pollution 'hot spots' have been identified, and short-term monitoring indicates that this requires fuller investigation. Specific measurements taken at industrial outfalls call into question the claims of larger industries not to be major polluters (Research Paper 6). Further investigations would be required to establish linkages between the longer-term record of pollution and the effects on this of individual polluting events.

The effects of urban pollution are most keenly felt downstream of the city, where, in addition, preliminary research at Asago shows a significant build-up of heavy metals in fish tissue, river and overbank sediments (Section 4.8). This has important implications for human health, and warrants further investigation.

An inspection of the rainfall records from Kumasi Airport shows a significant decline of total rainfall in recent decades. Together with progressively increasing abstraction of groundwater due to continuing urbanisation and the apparently unregulated increase of individual boreholes and hand-dug wells, this situation indicates progressively increasing demands on a diminishing aquifer. Although assessed here as not as yet problematic (see Section 4.7), should these climate and urbanisation trends continue, some prejudicing of aquifer water seems inevitable. Already, there is evidence from downstream of the city, of contamination of the relatively shallow groundwater tapped by hand-dug wells.

The deterioration in water quality as the city is approached is mirrored by a deterioration in the general condition of the natural environment. Soil erosion is not a major problem compared with many other developing areas, but significant erosion occurs in villages, undermining houses and gullying roads. One obvious contributor to this is the practice of clearing all vegetation from house frontages on village roads. Sand winning areas are also conspicuously degraded and, despite permit conditions requiring it, the rehabilitation of these areas by replacing topsoil was not seen in the Project area.

Litter is more or less ubiquitous, and is exacerbated by the presence of informal refuse dumps along roads and on river banks. KMA collections from village dumps are irregular at best, and this undoubtedly presents a health hazard. More generally, there is no culture of not littering among local residents, while wind-blown polythene bags also represent a significant problem.

The discharge of effluents and sawmill and carpentry waste into the rivers further exacerbates this situation. The effects of this are seen most obviously downstream of the industries concerned and in the peri-urban zone beyond, where, following flood waves, the floodplain is littered with sawmill debris and faecal wastes. This situation is worsened by the presence in the floodplain area of a set of KMA temporary settlement ponds, which are breached and seen to overflow into the main river. This picture of, effectively, using the rivers as an informal dump for wastes of all sorts completes the circle of deteriorating environmental and water quality. Some sawmills also dump and burn substantial quantities of wood offcuts, shavings and sawdust, either on their own premises or on vacant land in the peri-urban area. This generates substantial smoke and dust pollution.

8.4.2 Evaluations of Project awareness-raising activities and products and interventions

As reported in Section 7, results are variable but the overall impact of the Project's activities is unmistakeable. The leaflets were generally felt to be appropriate, and many respondents appreciated the bilingual production. Children were particularly enthusiastic about the message of water quality protection.

Unfortunately, one key use for the leaflets, namely in adult literacy classes run by CEDEP, and where their impact would have been easy and relevant to evaluate given the controlled context, did not materialise on account of the cessation of those classes.

The water test kits in schools clearly fulfilled an important role and served not only to raise the awareness of the children directly involved and some of their peers, but also to help enliven and make more relevant part of their school syllabus. The extent to which this testing contributed to wider community awareness also varied among the villages, but the plays and poetry readings undertaken by the JSS pupils certainly had an impact at the public durbars. The role of dynamic headteachers and/or science teachers was clearly central – both to the way in which JSS pupils were involved and enthused, and in terms of wider community dissemination. Variation was only to be expected, since we did not prescribe any specific activities; rather, we provided intial demonstrations and made some pertinent suggestions. This enabled us to observe how different staff and groups of pupils responded. To be sure, occasional problems of pupil selection and teacher continuity did arise but overall the results were most encouraging. Furthermore, there is no doubt that the frequent visits by EPA and other Project staff to the villages for liaison and other Project activities, raised the profile of these activities and, more generally, of local environmental problems.

The uptake of, and response to, the various WMF activities, especially the participatory micro-intervention demonstrations, was positive overall, although also variable both within and between villages. In Adagya, Asago and Maase, for instance, a consistent level of widespread interest was evident; elsewhere it was more variable and in the most urban villages of Abrepo and Sepetinpom only a handful of people appeared to engage with the Project more than briefly. A committed chief/*odikro*, Unit Committee or WATSAN chair or secretary would make a substantial difference. Conversely, occasional delays in providing the demonstrations and follow-up extension work by the Project may have contributed to disappointment and a loss of interest. In several cases, the CLFs were able to stimulate interest within a short period toward the end of the Project.

Overall, the experience of these activities and evaluations suggests clearly that

- responsiveness and uptake was generally most pronounced in the more rural villages, namely Adagya, Asago and Maase, where communal spirit and identity, and the role of traditional leaders were still most evident. Conversely, the most urban, i.e. Abrepo and Sepetinpom, had lost much of that ethos, and people were more concerned for their own families and households. Hence any communal activities were far harder to organise or sustain. Even getting a reasonable attendance at research or awareness-raising meetings was difficult, with Project staff having to make repeated and often frustrating visits. In the intermediate villages of Atafua, Esereso and Duase, circumstances varied, in some cases resembling more urban responses and in others more rural. This experience is entirely consistent with the notion of the PUI elaborated above, and where increasing urbanisation is quite rapidly reflected in more urban lifestyles and behaviour, even if the village retains traditional leadership and aspects of its identity and territory.
- Depending on their specific nature, evaluation of individual one-off events or products in terms of their impact (as distinct from quality) proved problematic in practice. Relevant examples include the cartoon leaflet and radio broadcasts. It is very difficult to attempt to measure changes in public awareness, let alone behaviour, from single actions and interventions. These are longer term and complex processes, with behavioural change often resulting from cumulative exposure to consistent messages. (Single traumatic events may also have this effect but are not relevant in the present context). Even seeking to measure such changes at the end of the project might be premature. Indeed, it would be instructive to conduct a follow-up evaluation a year or two later in order to see whether the participatory activities and the role of the CLFs have actually become sustainable once financial and support inputs by Project staff have ended.

8.4.3 Prioritisation of the Poor

As explained above, it was difficult to adjust our work programme substantially once the research activities had been commenced. We did conclude that it was inadequate simply to regard all peri-urban villages and villagers as poor – a view proposed by some local collaborators. The evidence from our watershed village characterisation study, and from our on-going contacts with the communities showed clearly that even the smaller villages contained substantial socio-economic differentiation. One interesting example was the take-up of electricity in Asago following the village's connection to the distribution grid during an early stage of our Project.

We were also sensitive to recent poverty discourses that highlight wider dimensions of poverty than income and material assets. In particular, relative access to power is an important differentiator even at this level, for instance, in terms of social distance from the chief or elders, or membership of the political party in power. Vulnerability to shocks is also a major problem of poverty. The WVCS survey revealed the diversity of livelihood activities among individuals and households within the sample of villages, some of which might be correlated with poverty, although our research design (determined at the outset of the Project) was not fine-grained enough to allow such retrospective analysis.

Moreover, since our project was focused on sustainable natural resource utilisation at the watershed scale, rather than on identifying poor people per se, It was not appropriate to devote the time and resources to undertaking detailed supplementary research later on that would accord fully with the asset-vulnerability framework or livelihoods strategy, even though this has now been adopted an 'official' DFID methodology. Rather, we needed to be aware of the major dimensions of differentiation and potential exclusion in the study villages and to take appropriate measures to include and prioritise the poorer segments. Discussions with villagers on the subject also proved difficult as the issue is sensitive and perceptions of poverty vary widely. Certainly, chiefs and elders, and other wealthier individuals did not prove very reliable on this. Teachers, nurses and midwives, by contrast, often have good appreciations of the nature and extent of local poverty.

Ultimately, inclusion of a wide spectrum of people in focus groups and participatory appraisals, ensuring that poor villagers benefited from awareness-raising activities, and that the micro-interventions we demonstrated would be affordable, were the most important mechanisms we adopted to achieve representation of the poor. We also found that, although some of the poor were available during the day on account of their unemployed status, others were too preoccupied with day-to-day survival to attend and participate in Project demonstration activities. Even in project R7995, where the preparation of livelihood plans necessitated a very specific focus on the poor in each community, it proved difficult to ensure this outcome. For instance, the (necessary) literacy requirement for training as a CLF excluded many poor people.

8.4.4 Distinctiveness of the PUI and NR issues within it

Our research leads us to the clear conclusion that the PUI is most appropriately conceived of as something of a continuum (although not necessarily with a simple linear form) between the poles of urban and rural. The width and nature, and even particular boundaries, of the PUI are dynamic and subject to rapid change according to the pace of urban growth and related processes. The distinctiveness of the PUI is therefore twofold:

- this spectrum of conditions from de facto 'urban' to 'rural', with the most intensive impacts of urban influence occurring in the 'inner' zone closest to the growing city; and
- the rapid change in conditions, with a changing balance between essentially urban and rural features.

The implications of this for natural resource use, environmental quality and NR-based livelihoods follow fairly logically:

- we found no unique or distinctive NR uses and livelihood activities associated with the PUI *and that did not occur elsewhere as well*
- rather, as villages begin to experience urban influences – in terms of improved access, changing pressures on land-use and natural resources, increasing pollution, arrival of outsiders seeking affordable accommodation, reduced prices for manufactured goods etc – their rural character starts to change, *with a progressive shift towards combinations of rural and urban features, activities and facilities*. Ultimately, when urbanisation is complete, such areas are no longer peri-urban
- in terms of natural resources, there is a progressive shift from agriculture and pastoral land-use towards residential and then commercial or industrial use, with associated increases in land values but losses of entitlement on the part of some farmers if appropriate compensation is not forthcoming, and hence a sometimes dramatic impact on their livelihoods. Similarly, pressure on woody biomass for fuelwood or through land clearance intensifies, leading to scarcity and perhaps commoditisation as its collection and sale become livelihood activities for some people. Sandwinning commonly also increases in areas of appropriate soil, with environmental impacts, including possibly on health if rehabilitation is not undertaken to prevent the breeding of disease vectors in water-filled borrow pits or windblown erosion of exposed soil. Available land for other purposes also declines. Water and air pollution from the city commonly increase, while intensive agriculture or livestock/poultry rearing for urban markets, along with inappropriate disposal of the growing volumes of human waste and refuse, may contaminate the groundwater and rivers
- In terms of livelihood strategies, the increase of urban pressures therefore leads to adaptation and diversification for most people, particularly the relatively and absolutely poor. Where possible, this may result in a combination of rural and urban livelihood activities, e.g. wage labour and cultivation. Otherwise, different non-urban activities may become necessary, using traditional skills (e.g. craft production for urban or tourist markets) or new ones (e.g. motor car repair). Certain environmentally harmful activities that use natural resources do tend to concentrate in peri-urban areas, where the land or other resources are still available. Examples include car washing adjacent to rivers or streams, and stone crushing for the roadbuilding and construction industries. However, even these are not distinctively peri-urban, and not all those who carry them out are peri-urban residents.

8.5 REFLECTIONS ON METHODOLOGY

Changes to the research agenda during the life of the Project, and their implications, along with particular problems and limitations of individual activities, have been covered in the foregoing discussion. More detailed coverage can be found in Sections 4, 5 and 7.

In addition, it is appropriate to draw attention to a wider set of issues pertaining to the difficulties of achieving a genuine North-South research partnership in situations such as this, where the UK and Ghanaian partners are working under very different conditions and constraints. As a result, perceptions and priorities may differ and the system of short but intensive field visits from the UK may not harmonise well with the day-to-day pressures of Kumasi team members. Cultural and other behavioural factors, such as punctuality and keeping to agreed work schedules, as well as more logistical problems, such as frequent electricity or Internet connection interruptions, also play a role.

On the other hand, the combination of diverse skills, experience, theoretical and practical knowledge and expertise, and the range of contacts (gatekeeper access) represented by the team assembled for this project, has been very positive in many ways, enabling progress in ways that a smaller or uninational team might have found very difficult. Certain activities could be kept going by colleagues when someone was otherwise committed. Certainly, too, transfer of knowledge and skills took place in both directions.

We have examined these issues, which are clearly generic rather than of specific relevance only to this Project, in Research Paper 5, a revised version of which has been prepared for publication in early 2003.

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FINAL TECHNICAL REPORT
R7330

APPENDICES

November 2002

DFID Natural Resources Systems Programme

IRNR

CEDAR

Appendix A Original logframe

NARRATIVE SUMMARY	Objectively Verifiable Indicators	Means of Verification	Important Assumptions
Goal Management of peri-urban resources optimised through improved productivity and energy efficiency; crop production intensified on a sustainable basis; productive potential increased by the greater use of 'waste' materials and recycling of resources			
Purpose Impacts of urban growth on land use patterns and natural resources degradation identified and incorporated into strategies for peri-urban planning and management	Implementation of appropriate district and watershed level planning/management systems	Monitoring of policy agenda and public announcements	Political will exists to translate project outputs into practical policies and implementation thereof Target institutions invest in the uptake and application of methodologies and technology
Outputs **1. Inception phase** A. Network of research partners established B. Preliminary identification and prioritisation of problems affecting water resources in the watershed areas and the effects on peri-urban inhabitants C. Characterisation of the physical environment, and study watershed areas agreed D. Characterisation of the water resource environment E. Data requirements and data collection methods for physical and socio-economic data identified and designed F. Literature search: watershed management in peri-urban areas elsewhere G. Inception report	1. Completion of the Inception phase by July 1999	1. Inception Report produced on time	1. 1 January 1999 start 1.2 Cooperation of potential partners and stakeholders 1.3 Access to existing databases
2. Analysis of the watersheds and development of strategies for sustainable management		2A-F. Project reports and GIS interface creation and outputs	
A. Human activity in the watersheds analysed 1. Stakeholder analysis of those involved in watershed management and use 2. Socio-economic surveys	2A.1 Analysis of stakeholders completed January 2001 2A.2 Results of village characterisation surveys presented December 1999 Analysis of perception of water resources completed Janaury 2001	2A. Presentation of results to village groups/fora. Interim report on findings.	2. Cooperation of stakeholders during surveys
3. Farming system impact on water resources in selected watersheds	2A.3 Farm system analysis completed December 1999		
B. Characterisation of the physical parameters of selected watersheds	2B. 1 Analysis of physical and land use parameters of watersheds completed January 2001 2B.2.Erosion/land degradation risk maps produced April 2001	2B. Production of erosion/land degradation risk maps for selected watersheds	
C. Sustainable and low-cost methods of environmental/pollution monitoring established	2C. Establishment of network of monitoring sites December 1999	2C. Local communities' involvement in environmental monitoring	
D. Watershed diagnostic framework developed using KUMINFO	2D. Watershed diagnostic framework development within KUMINFO started December 1999; development completed June 2001	2D. Map/display output	
E. Policy recommendations for watershed management at national, regional and district levels	2E. Draft formulation of strategy proposals and specific policy elements August 2000		2.D. Continued access to Kuminfo assured
F. Development of a community-based pilot watershed management plan: a generic diagnostic framework for peri-urban watersheds (PAMP)	2F. Development of PAMP started December 1999	2E. Publication of strategy proposals	
3. Monitoring the effectiveness of practical solutions A. Establish sustainable and low-cost methods of environmental/pollution monitoring	3A. Establishment of network of monitoring sites December 1999	2F Development and implementation of PAMP through appropriate NGOs and GWSC 3A. Local communities' involvement in environmental monitoring	
B. Use of KUMINFO as an interactive medium for environmental education	3B. Augmentation of KUMINFO database and production of maps,		
C. Implement community-based pilot watershed management plan: a generic diagnostic framework for watershed management in peri-urban areas	3C.1 Prototype PAMP produced August 2000 3C.2 PAMP tested and refined June 2001; produced July 2001	3B. GIS interface creation and outputs 3C. Development and implementation of PAMP through appropriate NGOs and GWSC	3. 1 Cooperation of stakeholders during site establishment and monitoring 3.2 Authorities are willing to transfer proposals into policies 3.3 Appropriate NGO and GSWC follow-up of pilot area management plan 3.4 Continuing access to KUMINFO assured
4. Dissemination through the life of the project: 'selling' the practical solutions Using Twi leaflets, liaison/discussion, workshops, conference presentations, publications, research monograph Development of communication strategies for dissemination of outputs	4. 1 Communication strategy in place December 1999 4.2 Dissemination literature system in place December 1999 4.3 Media information systems in place December 1999 4.4 Working paper series started February 2000 4.5 Annual Reports December 1999 and 2000 4.6 Final report presented December 2001, to be followed by submissions to journals and submission of research monograph to commercial publisher 4.7 Feedback from workshops/dissemination seminars	4. 1 Increased environmental and resource awareness, and changing behaviour, within the local communities 4.2 Publication of project results 4.3 Citation and peer comment on project output 4.4 Reception of, and response to, preliminary and final findings and proposals at workshops/seminars	4. continued involvement of stakeholders in project activities and outputs

Activities

1. Inception Phase

A. Network of research partners established:

- liaison with stakeholders at all levels
- announce research internationally and set up liaison, eg UNEP, HABITAT
- identification of the main participants for the various surveys/research activities

B. Preliminary identification and prioritisation of problems affecting water resources in the watershed areas and the effects on peri-urban inhabitants:

- local difficulties regarding water resources management
- local solutions and establish which ones work and why
- problems which make local solutions difficult
- local ideas for reducing perceived difficulties
- range of land uses, including farming activities, which impinge on water resources
- Local Agenda 21 issues and principal actors

C. Characterise the physical environment, and select target watersheds:

- assessment of hydrological and geomorphological factors
- assess existing database on hydrological, soil and geomorphological parameters
- identify existing range of land use 'best practice',
- identify watersheds for study

D. Characterise the water resource environment:

- identify the range of environmental problems related to water resource use
- identify/confirm the sources of these problems
- identify the major types of water pollution
- identify the causes of water pollution
- identify agriculture/water resource problems in target watersheds
- identify environmental problem 'hot spots'
- define (if necessary) supplementary transect locations

E. Identify and design data requirements and methods

- ascertain potential for collaborative activities
- assess existing database
- design surveys
- define the need for village characterisation survey
- design proformas for systematic field observation

F. Literature Search

G. Inception Report

Year	*1998/9*	*1999/2000*
Staff Costs	2640	20650.4
Overheads	2160	20113.6
Equipment	1232	400
Overseas Travel	2200	12716
Miscellaneous	1350	16394
VAT	-	-
TOTAL	9582	70274

Year	*2000/1*	*2001/2*
Staff Costs	7761.7	11769.2
Overheads	6844	10278.1
Equipment	400	400
Overseas Travel	4630	4586
Miscellaneous	12288	11154
VAT	-	-
TOTAL	31923.7	38187.3

1. Inception Report

1. 1 Cooperation of potential partners and stakeholders
1.2 Access to existing data bases
1.3 Suitable pilot watershed can be identified

2. Analysis of the watersheds and development of strategies for sustainable management

A1. Stakeholder analysis of those involved in watershed management and use

- implement a survey of government bodies who use the watershed
- implement a survey of stakeholders who use the watershed
- implement a survey of polluting stakeholders
- analysis of existing institutional capacities, policies and practices in respect of regulation, control and enforcement. (this includes both customary and statutory institutions and practices)
- assess the effectiveness of environmental control
- identify any recent or projected changes in local/national ownership which may affect environmental management
- determine appropriate communication strategies through 'audience profiling'

A2. Socio-economic survey and activities

- implement as necessary a Village Characterisation Survey for those villages which affect the watershed
- assess the basis of local perceptions using PRSA-type methodologies to:
  - assess the impact of local land use practices on water resources
  - assess perceived local difficulties regarding water resources management
  - assess the effectiveness of local solutions - what have they actually applied and is it effective
  - assess problems which make local solutions difficult
  - assess local ideas for reducing perceived difficulties
  - assess Local Agenda 21 issues and principal actors
  - encourage local participation to identify better solutions

2. 1 Published analyses

2.2 Annual and Final Reports

2.3 KUMINFO GIS outputs

2. 1 Cooperation with all stakeholders is forthcoming

2.2 Field surveys are not disrupted by exceptional weather

2.3 Measurements and instruments are not disturbed or vandalised

A3. Farming system impact on water resource use in selected watersheds • demands and effects of farming systems on water flows and availability • effects of possible changes in water quantity and quality at farm level • potential requirements for water conservation measures at farm level **B. Characterisation of the physical parameters of selected watersheds** • establish protocols and take measurements of pollution in selected watersheds identify sources, pathways and sinks for significant polluting activities and their effects on water quality identify any annual patterns in hydrological and pollution levels identify effects of pollution on biota • establish nature and extent of erosion risk • establish nature and extent of land degradation risk • establish criteria for local monitoring of degradational activities low-cost water quality monitoring: site selection and user training development of leaflets, etc to assist self-monitoring **C. Sustainable and low-cost methods of environmental/pollution monitoring established** • identify sites and stakeholders appropriate to the establishment of low-cost water quality monitoring activities • identify options to minimise effects of pollutants within the watershed • identify ways of reducing existing or perceived water resource problems • identify options to attain a land use mix consistent with sustainable use of water • identify waste recycling opportunities in selected watersheds using existing database **D. Watershed diagnostic framework using KUMINFO** • development of watershed diagnostic framework within KUMINFO digital elevation model of selected watersheds simple model of surface and groundwater hydrology characterisation of areas of erosion and land degradation risk			2B. appropriate sites available anbd accessible to the project
E. Develop policy recommendations at national, regional and district levels (see also 3C below) • assess effectiveness of current policies which impact on environmental management (particularly water-related issues) • assess the implications of any recent or projected changes in local/government ownership which may affect environmental management (particularly water-related issues) **F. Develop a community-based pilot area management plan** (see also 3C below). This will be based on the results of consultation with stakeholders on: • economic needs of local people • requirements of polluting stakeholders • interface with national and local policy • Local Agenda 21 issues It will be informed by: • surveys of best practice • the physical characteristics of the watershed • existing land use practices (including farming) • survey information on water resource uses and problems		2D. Map/display output	2D. Continued access to KUMINFO assured
3. Monitoring the effectiveness of practical solutions **A. Establish sustainable and low-cost methods of environmental/pollution monitoring and dissemination of appropriate information to stakeholders** • investigation of feasibility of using low-cost field kits, designed specifically for use in the peri-urban village context for monitoring water quality and pollution problems • establishment of 'user-friendly' visual methods of recognising the onset of water quality and land use problems such as accelerated erosion • establish pathways for the scientific corroboration of existing or emerging environmental problems, specifically those relating to water resources • establish protocols for reporting of unauthorised landuses and land transactions, waste tipping, sand/gravel winning, etc, which affect water resources		3A.1 Field implementation of products of research, including use of field kits by stakeholders 3A.2 Pathways for uptake of self-monitoring operational	3A. Uptake of products of research by stakeholders

Activites (cont.)

B. Use of KUMINFO as an interactive medium for environmental education • establishment of protocols for inputting environmental information into KUMINFO • investigation of KUMINFO as a demonstration medium for watershed-scale relationships between the physical environment, water resources and human activities • use of KUMINFO to illustrate potential effects of development decisions on the water resource environment, on erosion risk and on land degradation risk • development of a diagnostic framework within KUMINFO to inform a pilot area management plan and illustrate water resource linkages with best practice		3B. Use of KUMINFO by stakeholders3	3B. Continued access to KUMINFO assured
C. Implement community-based pilot watershed management plan: a generic diagnostic framework for watershed management in peri-urban areas The critical research activities which will underpin plan development include (see also 2E and 2F above): • consultation procedures described • policies established for environmental protection (particularly water-related issues) • land use allocation criteria described • land use allocation process outlined • map and description of land utilisation types and land mapping units • procedures for representation of applications for consent .		3C. 1 Uptake of project output by policy bodies. 3C.2 Implementation of pilot area management plan through appropriate NGO and GWSC	3C. 1 Authorities are willing to transfer proposals into policies 3C.2 Appropriate NGO and GWSC followup
4. Dissemination through the life of the project: 'selling' the practical solutions using Twi leaflets and local broadcasting network, liaison/discussion, workshops, conference presentations, publications, research monograph • liaison/discussion with local government staff regarding local issues - eg Local Agenda 21, use of the watershed • liaison/discussion with national government representatives - eg GWSC • liaison/discussion with stakeholders causing pollution and other forms of environmental degradation - eg timber companies • liaison/discussion with local communities both upstream and downstream of sites of degradation via BIRD and CEDEP/GOAN • liaison/discussion with other key informants and stakeholders including private firms, parastatals and official agencies whose activities leave an environmental 'footprint' in the peri-urban area • 'audience profiling' to determine appropriate communication strategies - carried out in conjunction with stakeholder surveys • workshops will be held in Kumasi at key stages of the project (a) to aid in project design (b) to encourage participation in project activities (c) to assist in ensuring uptake pathways (d) to disseminate research progress and results locally and nationally • use of descriptive and information leaflets in Twi to inform stakeholders • use of local broadcasting networks to inform stakeholders of project activities and goals • announce research results internationally (professional newsletters, seminars, conferences, email discussion groups and bulletin boards) and link in with international databases eg UNEP • peer refereed journal papers; conference presentations and proceedings; research monograph • dissemination seminar in UK at end of project • liaison/discussion with international interested parties - eg HABITAT		4. 1 Increased environmental and resource awareness at local levels 4.2 Changing behaviour at local levels 4.3 Published output of project	4. continued involvement of stakeholders in project activities and output

Activites (cont.)

Appendix B Revised logframe

NARRATIVE SUMMARY	Objectively Verifiable Indicators	Means of Verification	Important Assumptions
Goal Management of peri-urban resources optimised through improved productivity and energy efficiency; crop production intensified on a sustainable basis; productive potential increased by the greater use of 'waste' materials and recycling of resources			
Purpose Impacts of urban growth on land use patterns and natural resources degradation identified and incorporated into strategies for peri-urban planning and management	Implementation of appropriate district and watershed level planning/management systems	Monitoring of policy agenda and public announcements	Political will exists to translate project outputs into practical policies and implementation thereof Target institutions invest in the uptake and application of methodologies and technology
Outputs **1. Inception phase** A. Network of research partners established B. Preliminary identification and prioritisation of problems affecting water resources in the watershed areas and the effects on peri-urban inhabitants C. Characterisation of the physical environment, and study watershed areas agreed D. Characterisation of the water resource environment E. Data requirements and data collection methods for physical and socio-economic data identified and designed F. Literature search: watershed management in peri-urban areas elsewhere G. Inception report	1. Completion of the Inception phase by September 1999. Report by December 1999	1. Inception Report produced on time	1. 1 April 1999 start 1.2 Cooperation of potential partners and stakeholders 1.3 Access to existing databases
2. Analysis of the watersheds and development of strategies for sustainable management A. Human activity in the watersheds analysed 1. Stakeholder analysis of those involved in watershed management and use 2. Baseline socio-economic surveys including survey of water use/perceptions of water resources	2A.1 Analysis of stakeholders completed January 2001 2A.2 Results of village characterisation surveys presented March 2000 Analysis of perception of water resources completed March 2001	2A-F. Project reports and GIS interface creation and outputs 2A. Presentation of results to village groups/fora. Interim report on findings.	2. Cooperation of stakeholders during surveys
3. Farming system impact on water resources in selected watersheds	2A.3 Farm system analysis completed December 1999		
4. Enhanced understanding gained of existing community watershed activities and management practices in peri-urban interface	**2A.4 Existing community activities and management practices documented by July 2001**	**Report on management practices completed and relevant information incorporated within KUMINFO**	That active management practices exist
B. Characterisation of the physical parameters of selected watersheds	2B. 1 Analysis of physical and land use parameters of watersheds completed March 2001 2B.2.Erosion/land degradation risk assessment produced September 2001 2B3. Characterisation of hydrological system and impacts on it drafted by September 2001	2B. Production of erosion/land degradation risk assessment for selected watersheds Production of basic model of hydrological relationships in catchments	
C. Sustainable and low-cost methods of environmental/pollution monitoring established	2C. Establishment of network of monitoring sites December 1999	2C. Local communities' involvement in environmental monitoring	
D. Watershed characterisation framework developed using KUMINFO	2D. Watershed characterisation framework development within KUMINFO started June 2000; development completed December 2001	2D. Map/display output	2.D. Continued access to Kuminfo assured
E. Formulate peri-urban community watershed management recommendations for national, regional and local authorities	2E. Draft formulation of strategy proposals and specific policy elements October 2001	2E. Draft consultation manual	
F. Development of a framework for improved community-based watershed management in peri-urban interface	2F. Development of framework started August 2000, in conjunction with appropriate NGOs and EPA	2F Draft and then final framework (including manual of best practice) completed and applied as key project activities and outputs	

Outputs (cont) G Lessons learned from experience of participatory research and the monitoring of microprojects and other interventions by this project to enhance management 1. Evaluation of Twi and English leaflets 2. Evaluation of schools' use of water test kits and subsequent information, dissemination and behavioural change 3. Evaluation of watershed management framework-related demonstration projects 4. Evaluation of watershed management framework and best practice manual	2G. Evolution of community perceptions and practices, and impact of microprojects, documented by March 2002 2G1 Draft report completed August 2001 2G2 Draft report completed September 2001 2G3 Evaluation included in FTR 2G4 Evaluation included in FTR		2G Stakeholders willing to consider involvement in development of strategies for better environmental management
3. Monitoring the effectiveness of practical solutions A. Establish sustainable and low-cost methods of environmental/pollution monitoring B. Use of KUMINFO as an interactive medium for environmental education C. Evaluate community-based watershed management framework and demonstration activities as stimulants for watershed self-management	3A. Establishment of network of monitoring sites December 1999 3B1. Augmentation of KUMINFO database and production of maps 3B2 local viability and sustainability of KUMINFO established as participatory educational and planning tool 3C.1 Prototype framework produced March 2001 3C.2 framework tested and refined December 2001; amendments and final versions evaluated by March 2002	3A. Local communities' involvement in environmental monitoring 3B1. GIS interface creation and outputs 3B2 Use of products by stakeholders; interaction between stakeholders and KUMINFO 3C. preliminary evaluation reports drafted August –October 2001; FTR contains final evaluation	3. 1 Cooperation of stakeholders during site establishment and monitoring 3.2 Authorities are willing to transfer proposals into policies 3.3 Appropriate NGO and GSWC follow-up of pilot area management plan 3.4 Continuing access to KUMINFO assured 3.5 KUMINFO staff proactive in interactions with stakeholders
4. Dissemination through the life of the project: 'selling' the practical solutions Using Twi leaflets, liaison/discussion, workshops, conference presentations, publications, research monograph Development of communication strategies for dissemination of outputs Development of website	4. 1 Communication strategy in place March 2000 4.2 Dissemination literature system in place March 2000 4.3 Working paper series started July 2000 4.4 Annual Reports March 2000 and March 2001 4.5 Final report presented March 2002, to be followed by submissions to journals and submission of research monograph to commercial publisher 4.6 Feedback from workshops/ dissemination seminars 4.7 Use of website	4. 1 Increased environmental and resource awareness, and changing behaviour, within the local communities 4.2 Publication of project results 4.3 Citation and peer comment on project output 4.4 Reception of, and response to, preliminary and final findings and proposals at workshops/seminars 4.5 number of hits on website	4. continued involvement of stakeholders in project activities and outputs

NB. OVI and MoV numbers not identical as some MoVs are generic

Activities					
1. Inception Phase				1. Inception Report	1. 1 Cooperation of potential partners and stakeholders 1.2 Access to existing data bases 1.3 Suitable pilot watershed can be identified
A. Network of research partners established:	*Year*	*1998/9*	*1999/2000*		
• liaison with stakeholders at all levels					
• identification of the main participants for the various surveys/research activities	Staff Costs	2640	20650.4		
B. Preliminary identification and prioritisation of problems affecting water resources in the watershed areas and the effects on peri-urban inhabitants:	Overheads	2160	22574.3		
	Equipment	1232	400		
• local difficulties regarding water resources management	Overseas Travel	2200	16546		
• local solutions and establish which ones work and why	Miscellaneous	1350	16394		
• problems which make local solutions difficult	VAT	-	-		
• local ideas for reducing perceived difficulties					
• range of land uses, including farming activities, which impinge on water resources	TOTAL	9582	76564.7		
• Local Agenda 21 issues and principal actors					
C. Characterise the physical environment, and select target watersheds:					
• assessment of hydrological and geomorphological factors	*Year*	*2000/1*	*2001/2*		
• assess existing database on hydrological, soil and geomorphological parameters					
• identify existing range of land use 'best practice',	Staff Costs	30979	15821		
• identify watersheds for study	Overheads	13323.9	12128.3		
D. Characterise the water resource environment:	Equipment	6172	400		
• identify the range of environmental problems related to water resource use	Overseas Travel	12769	9887		
• identify/confirm the sources of these problems	Miscellaneous	17178	13156.7		
• identify the major types of water pollution	VAT	-	-		
• identify the causes of water pollution					
• identify agriculture/water resource problems in target watersheds					
• identify environmental problem 'hot spots'	TOTAL	80421.9	51393		
• define (if necessary) supplementary transect locations					
E. Identify and design data requirements and methods					
• ascertain potential for collaborative activities					
• assess existing database					
• design surveys					
• define the need for village characterisation survey					
• design proformas for systematic field observation					
F. Literature Search					
G. Inception Report					
2. Analysis of the watersheds and development of strategies for sustainable management					
A1. Stakeholder analysis of those involved in watershed management and use				2. 1 Published analyses	2. 1 Cooperation with all stakeholders is forthcoming
• implement a survey of government bodies with activities in and responsibilities for the watersheds				2.2 Annual and Final Reports	
• implement a survey of stakeholders who use the watersheds					2.2 Field surveys are not disrupted by exceptional weather
• implement a survey of polluting stakeholders				2.3 KUMINFO GIS outputs	
• analysis of existing institutional capacities, policies and practices in respect of regulation, control and enforcement. (this includes both customary and statutory institutions and practices)					2.3 Measurements and instruments are not disturbed or vandalised
• assess the effectiveness of environmental control					
• identify any recent or projected changes in local/national ownership which may affect environmental management					
• determine appropriate communication strategies through participatory research and evaluations					
A2. Socio-economic survey and activities					
• implement as necessary a Village Characterisation Survey for those villages which affect the watershed					
• assess the basis of local perceptions using PRA-type methodologies to:					
assess the impact of local land use practices on water resources					
assess perceived local difficulties regarding water resources management					
assess the effectiveness of local solutions - what have they actually applied and is it effective					
assess problems which make local solutions difficult					
assess local ideas for reducing perceived difficulties					
assess Local Agenda 21 issues and principal actors					
encourage local participation to identify better solutions					

A3. Farming system impact on water resource use in selected watersheds • demands and effects of farming systems on water flows and availability • effects of possible changes in water quantity and quality at farm level • potential requirements for water conservation measures at farm level A4. Enhanced understanding of existing activities and management practices • assess from elements abstracted from A1-A3 above • assess from perceptual surveys of target communities • test existing knowledge through demonstration and PRA-type activities **B. Characterisation of the physical parameters of selected watersheds** • establish protocols and take measurements of pollution in selected watersheds identify sources, pathways and sinks for significant polluting activities and their effects on water quality identify any annual patterns in hydrological and pollution levels identify effects of pollution on biota • establish nature and extent of erosion risk • establish nature and extent of land degradation risk • establish criteria for local monitoring of degradational activities low-cost water quality monitoring: site selection and user training development of leaflets, etc to assist self-monitoring **C. Sustainable and low-cost methods of environmental/pollution monitoring established** • identify sites and stakeholders appropriate to the establishment of low-cost water quality monitoring activities • identify options to minimise effects of pollutants within the watershed • identify ways of reducing existing or perceived water resource problems • identify options to attain a land use mix consistent with sustainable use of water • identify waste recycling opportunities in selected watersheds using existing database **D. Watershed characterisation framework using KUMINFO** • development of watershed characterisation framework within KUMINFO digital elevation model of selected watersheds simple model of surface and groundwater hydrology characterisation of areas of erosion and land degradation risk **E. Develop policy recommendations at national, regional and district levels (see also 3C below)** • assess effectiveness of current policies which impact on environmental management (particularly water-related issues) • assess the implications of any recent or projected changes in local/government ownership which may affect environmental management (particularly water-related issues) **F. Develop a community-based watershed management framework (see also 3C below).** This will be based on the results of consultation with stakeholders on: • economic needs of local people • requirements of polluting stakeholders • interface with national and local policy • Local Agenda 21 issues It will be informed by: • surveys of best practice • the physical characteristics of the watershed • existing land use practices (including farming) • survey information on water resource uses and problems **G. Lessons learned by Project to enhance management strategy** • distribution and evaluation of Twi and English leaflets • evaluation of schools' use of water quality test kits (see also 3A) • evaluation of dissemination of this new knowledge from children to their communities • installation and evaluation of watershed management demonstration microprojects • distribution and evaluation of watershed management framework and best practice manual		2D. Map/display output	2B. appropriate sites available anbd accessible to the project 2D. Continued access to KUMINFO assured

Activities (Cont)

3. Monitoring the effectiveness of practical solutions **A. Establish sustainable and low-cost methods of environmental/pollution monitoring and dissemination of appropriate information to stakeholders** • investigation of feasibility of using low-cost field kits, designed specifically for use in the peri-urban village context for monitoring water quality and pollution problems • establishment of 'user-friendly' visual methods of recognising the onset of water quality deterioration and land use problems such as accelerated erosion • establish pathways for the scientific corroboration of existing or emerging environmental problems, specifically those relating to water resources • establish protocols for reporting of unauthorised landuses and land transactions, waste tipping, sand/gravel winning, etc, which affect water resources		3A.1 Field implementation of products of research, including use of field kits by stakeholders 3A.2 Pathways for uptake of self-monitoring operational	3A. Uptake of products of research by stakeholders
B. Use of KUMINFO as an interactive medium for environmental planning and education • establishment of protocols for inputting environmental information into KUMINFO • investigation of KUMINFO as a demonstration medium for watershed-scale relationships between the physical environment, water resources and human activities • use of KUMINFO to illustrate potential effects of development decisions on the water resource environment, on erosion risk and on land degradation risk • development of a diagnostic framework within KUMINFO to inform watershed management and illustrate water resource linkages with best practice		3B. Use of KUMINFO by stakeholders3	3B. Continued access to KUMINFO assured
C. Implement community-based watershed management framework: a generic diagnostic framework for watershed management in peri-urban areas The critical research activities which will underpin framework development include (see also 2E and 2F above): • consultation procedures described • policies established for environmental protection (particularly water-related issues) • land use allocation criteria described • land use allocation process outlined • map and description of land utilisation types and land mapping units • procedures for representation of applications for consent		3C. 1 Uptake of project output by policy bodies. 3C.2 Implementation of pilot area management plan through appropriate NGO and GWSC	3C. 1 Authorities are willing to transfer proposals into policies 3C.2 Appropriate NGO and GWSC followup
4. Dissemination through the life of the project: 'selling' the practical solutions using Twi leaflets and local broadcasting network, liaison/discussion, workshops, conference presentations, publications, research monograph • liaison/discussion with local government staff regarding local issues - eg Local Agenda 21, use of the watershed • liaison/discussion with national government representatives - eg GWC, EPA, CWSA • liaison/discussion with stakeholders causing pollution and other forms of environmental degradation - eg timber companies • liaison/discussion with local communities both upstream and downstream of sites of degradation via BIRD and CEDEP/GOAN • liaison/discussion with other key informants and stakeholders including private firms, parastatals and official agencies whose activities leave an environmental 'footprint' in the peri-urban area • determine appropriate communication strategies - carried out in conjunction with stakeholder surveys • production of a Directory of all agencies with a stake in the Kumasi peri-urban environment • production of a Bibliography of relevant published/unpublished material • workshops will be held in Kumasi at key stages of the project (a) to aid in project design (b) to encourage participation in project activities (c) to assist in ensuring uptake pathways (d) to disseminate research progress and results locally and nationally • use of descriptive and information leaflets in Twi to inform stakeholders • use of local broadcasting networks to inform stakeholders of project activities and goals • establishment of Project website • announce research results internationally (professional newsletters, seminars, conferences, email discussion groups and bulletin boards) and link in with international databases eg UNEP • peer refereed journal papers; conference presentations and proceedings; research monograph • dissemination seminar in UK at end of project • liaison/discussion with international interested parties		4. 1 Increased environmental and resource awareness at local levels 4.2 Changing behaviour at local levels 4.3 Published output of project	4. continued involvement of stakeholders in project activities and output

Appendix C

DFID KUMASI WATERSHEDS MANAGEMENT PROJECT (R7330)

Revised Village Characterisation Survey Questionnaire 1999

Date _____ Interviewer _____

Village _____ District _____

List of Informants:

Name	**Occupation**

Section A Demographic Information

Village population

1. Total number of people _____ *[note if estimate only]*

Total of Males:_____ Total of Females: _____

2. Ethnic composition *[tick]*

Ethnic group	**None**	**Few/Some < 25%**	**about half 50%**	**most > 75%**	**almost all/all > 90%**
Indigenous					
Other southerners					
Other northerners					
Non-Ghanaians (*specify where from*)					

3. Since 1983 (the year of the bad drought), have more people (strangers) moved into the village or moved out? *[tick]*

More moved in_____ More moved out_____ About the same_____

What is the main reason for moving?

_____

4. Since 1983, have more indigenous people moved into the village or moved out? *[tick]*

More moved in_____ More moved out_____ About the same_____

What is the main reason for moving?

_____

Section B Village Structure & Institutions

1. Name of paramountcy containing village _____

2. Status of the Stool *[tick]*

   Paramount _____ Divisional _____ Village ____

   Sub-chief _____ no chief _____

   Other *[specify]* _____

3. Current occupant of stool *[tick]*

   Chief ____ Queen mother ____ Vacant ____

   other *[specify]* _____

4. Is a chief resident in village? Yes / No

   if no, how often does he come to village? *[tick]*

   > 1 x week ____ > 1 x month _____ < 1 x month ___

5. Is there a Queen Mother for the village? Yes / No

   Is Queen Mother resident in village? Yes / No

   if no, how often does she come to village? *[tick]*

   > 1 x week ____ > 1 x month _____ < 1 x month ___

6. Is the Assembly man resident in village? Yes / No

   if no, how often does he come to village? *[tick]*

   > 1 x week ____ > 1 x month _____ < 1 x month ___

7. Is there/has there been any chieftainship dispute in this village? If yes, please explain the main causes of this dispute.

Village & Community-based Organisations

8. Active organisations

Organisation	**Active in village** *[tick]*	**Who is involved? Men/ women / youth. Give total number of members.**	**Projects involved in**
Unit Committee			
Town Development Committee			
WATSAN (Water & sanitation groups). *Does it have links with CWSA?*			
Mobilisation & youth groups *(specify number of groups)*			
Communal work groups (nnoboa)			
Trade & market associations , cooperatives			
Religious organisations *(specify number of organisations)*			
other NGOs, eg 31st December Movement			
Political parties *(specify)*			
Locally-funded projects			
Outside-funded projects			

Section C Village land use, development & planning

1. Land Use: proportion of total village lands *[tick]* & changes since 1983 *[specify increase, decrease or no change]*

Land Use	**none**	**few/some < 25% total**	**about half 50% total**	**most > 75% total**	**Change in area since 1983** *[increase, decrease, or no change]*
Residential area					
Farm land -rainfed -irrigated					
Forest reserves					
Flooded areas (seasonally)					
Factory/ Commercial areas					
Sand winning sites					
other land use *[specify]*					

2. Land ownership: proportion of total village lands *[tick]* & changes since 1983 *[specify increase, decrease or no change]*

Land Owner	**none**	**few/some < 25% total**	**about half 50% total**	**most > 75% total**	**Change in area since 1983** *[increase, decrease, or no change]*
Stool land					
Family lands					
Individual lands					
Government lands					
Church lands					
Other *[specify]*					

3. Sacred or restricted areas in village: *[specify the number now and in 1983]*

Restricted area	**Number now (1999)**	**Number in 1983**
Fetish shrines		
Sacred groves		
Cemeteries		
Other restricted areas *[specify]*		

Residential areas

4. Number of numbered (registered) houses _____

5. Presence of new housing (in last 10 years): *[tick]*

   within old village area _____ in new residential area _____

6. Number of new (unnumbered) houses in residential areas:

   Completed houses _____ Unfinished houses _____

7. Presence of zongo area *[tick]* _____

8. Main changes in village land use since 1983

_____

_____

Future Developments

9. What developments are planned for the village? (e.g. residential, commercial, local government structures and changes)

_____
_____
_____
_____

Environmental issues

10. What are the environmental or pollution problems in village *(specify)*

_____
_____
_____
_____

Land issues

11. Any current land disputes in village? *(specify)*

_____
_____
_____
_____

12. **Any other main changes in the villages since 1983** (specify positive & negative changes)

_____
_____

Section D Water Resources, Energy and Waste Processing

1. Water courses and drainage

(a) Name(s) of nearest water course(s) _____
_____

(b) Any flooding or drainage problems?_____
_____

(c)Reasons for these problems?_____
_____

(d) What, if any, variations in water quantity and quality are there during the year?
_____
_____

(e) Are there any controls on use of land next to water courses e.g. taboos, local village/district rules?_____
_____

(f) Do villagers cultivate at/close to the banks of the water course?
_____

2. Sources of drinking water

Source	**%. of villagers using source** *[specify none, few, half, most, all]*	**Consistency of supply** *[specify constant, intermittent etc.]*	**Quality of water** *[specify good or poor; whether consistent or variable, and why and how often it varies]*	**Cost** *[specify per bucket or per house]*
Piped from Kumasi (GWSC)				
Bore hole				
Well				
Stream, river, lake				
Water tanks from Kumasi				
Harvested rainwater -specify method(s)				
Other *[specify]*				

3. Sources of water for washing clothes (c) and food and people (p)

Source	**% of villagers using source** *[specify none, few, half, most, all]*	**Consistency of supply** *[specify constant, intermittent etc.]*	**Quality of water** *[specify good or poor; consistent or variable, and how often it varies]*	**Cost** *[specify per bucket or per house]*
Piped from Kumasi (GWSC)				
Dam – say which one(s)				
Bore hole				
Well				
Stream, river, lake				
Water tanks from Kumasi				
Harvested rainwater - specify method(s)				
Other *[specify]*				

4. What are the main sources of water for livestock?

Source	**% of villagers using source** *[specify none, few, half, most, all]*	**Type of livestock** *[specify cattle, sheep,goats,pigs, poultry]*
Piped from Kumasi (GWSC)		
Dam – say which one(s)		
Bore hole		
Well		
Stream, river, lake		
Harvested rainwater		
Other *[specify]*		

5. What are the main sources of water and irrigation methods for crops apart from rain?

Source	**% of farmers using source** *[specify none, few, half, most, all]*	**Main types of crops grown**	**Irrigation method used (if any) [e.g. buckets, pump, water canals, pipes, sprinklers, bunding]**
Dam (say which one)			
Stream, river, lake			
Well			
Borehole			
Piped water			
Harvested rain – give method(s)			
Other *[specify]*			

6. **Who is responsible for collecting water for**
   (a) household use:_____
   (b) agriculture: _____
   (c) building construction: _____

7. **Is the cost of water** as given in answers to Questions 2 and 3 above affordable?
   _____
   _____

8. **Pollution of Water Sources**

(a) Are your sources of drinking water polluted? _____

(b) If so, how do you know/what is the evidence?_____
_____

(c) Are your sources of water for washing polluted? _____

(d) If so, how do you know/what is the evidence?_____
_____

(e) Are your sources of water for cultivation polluted? _____

(f) If so, how do you know/what is the evidence?_____
_____

(g) Who suffers most from poor water quality?_____
_____

(h) Why?_____

(i) What are the main effects?_____
_____

9. Access to water

(a) Who has access to irrigated lands, such as valley bottom farms?_____
(b) Are there disputes over water within the village?_____
(c) If so, why?_____
_____
(d) Are there disputes over water between villages?_____
(e) If so, why?_____
_____

Energy Sources

10a. Is there electricity in village? Yes / No 10b. Year installed _____
10c. Proportion of households with access to electricity *[tick]*

None	Few/some	about half	most	all

11. **Fuel for cooking** *[Ask women informants]*

Source	**% of villagers using source** *[specify none, few, half, most, all]*	**Where is the fuel obtained and by whom?** *[specify location, e.g. village; land outside village; Kumasi; where fuel is bought or collected] Who owns the rural or urban land where it is obtained?*	**Cost** *[specify for how much]*
Charcoal			
Fuelwood (bought)			
Fuelwood (own collection)			
Kerosene			
Gas			
Electricity			
Other *[specify]*			

Waste Processing

Waste water

12. What happens to waste water from houses?

Destination of waste water	**No. of villagers doing this** *[specify none, few, half, most, all]*
Poured into open drainage canals	
Poured into piped drainage system	
Used to irrigate crops	
Other [please specify]	

Refuse

13a. Refuse collection Yes / No

13b. If yes, who collects? _____

13c frequency of collection_____

13d. How many maintained and unmaintained refuse dumps are there? Maintained: _____ Unmaintained: _____

13e. Who maintains refuse dumps? _____

13f. What is done to maintain refuse dumps? _____

13g. How, if at all, is this work paid for? _____

13h. Where are the refuse dumps located? *[Fill for each refuse dump (tick)]*

Refuse dump	Adjacent to water course	Upstream from village	Downstream from village	Close to houses
1				
2				
3				

14. What is done with the following waste items?

Item	Put on refuse dump	Reused	Sold	Other *[specify]*
Bottles				
Tin cans				
Plastic bags				
Paper _____ **Veg/fruit waste**	_____	_____	_____	_____

Latrines

15a. Type of communal latrines

none ____ pit ____ VIP _____ other *[specify]*_____

15b. Night soil collection Yes / No

15c. if yes, who collects? _____

15d. frequency of collection_____

15e. who maintains latrines? _____

15f. How, if at all, is this work paid for? _____

15g. Where are the latrines located? *[Fill for each latrine site (tick)]*

Latrine site	Adjacent to water course	Upstream from village	Downstream from village	Close to houses
1				
2				
3				

16. Type of private toilet facilities

Type of facility	No. of houses in village *[specify none, few, half, most, all]*
None	
Pit	
VIP	
Flush into cesspit	
Flush into septic tank	
Flush into communal	

sewer	
Other [please specify]	

17. Institutional Structures:

(a) Does the village have any contact with outside institutions in respect of water management? _____

(b) If so, which institutions? _____

(c) For each institution, indicate how they help the village_____
_____
_____
_____

(d) Is there a village committee here which deals with water and sanitation issues?
_____

(e) Does it meet regularly? If so, how often?_____
_____

(f) How are water quality/pollution issues discussed and addressed in this village?
_____
_____

(g) Which authorities are contacted about water issues? _____

Section E ***Access to other facilities and infrastructure***

1. Schools

Type of school	**Number in village**	**Nearest outside village** *[give place name]*	**Distance to school** *[if outside village]*
Kindergarten			
Primary			
Junior Secondary			
Senior Secondary			
Other educational institutes *[specify]*			

2. Medical facilities

Type of service	**Number in village**	**Nearest outside village** *[place name]*	**Distance to service** *[if outside village]*
Doctor			
Nurse/health worker			
Trained midwife			
Traditional birth attendant			
Clinic/health centre			
Hospital			
Pharmacy			

3. Other facilities

Service	**in village** *[tick]*	**Nearest outside village** *[place name]*	**Distance to it** *[if outside village]*
Daily market			
Weekly / periodic market			
Telephones			
Post Office			
Chop bar or restaurant			

Transport

4a. Does public transport come to the village? Yes / No

4b. If so, what type of public transport vehicle? _____

4c. If no, how far from the village centre to catch public transport? ___ miles/km

5. Frequency of public transport to nearest market town & to Kumasi

Vehicle	Nearest market town			Kumasi		
	number per market day	number per other days	cost per person	number per day	cost per person	time taken
Trotros						
Taxis						
Other *[specify]*						

6. Distance to all year motorable road from village centre _____ miles/km

Section F Occupations and wages

Farming and non-farm jobs

1. Older men in farming [tick]

	none	**few /some < 25%**	**about half**	**most > 75%**	**almost all / all; > 90%**
farming full-time					
farming plus other jobs					
not farming fuelwood coll. Water coll. Waste management					

2. Older men: non-farm jobs

List the main non-farm occupations for older men in order of importance

1	
2	
3	
4	

3. Young men in farming [tick]

	none	**Few /some < 25%**	**about half**	**most > 75%**	**almost all / all; > 90%**
farming full-time					
farming plus other jobs					
not farming fuelwood coll. Water collect. Waste management					

4. Young men: non-farm jobs

List the main non-farm occupations for young men in order of importance

1	
2	
3	
4	

Women: Farming and non-farm jobs

5. Older women in farming [tick]

	none	**few /some < 25%**	**about half**	**most > 75%**	**almost all / all; > 90%**
Farming full-time					
Farming plus other jobs					
Not farming					
Fuelwood coll.					
Water collect.					
Waste management					

6. Older women: non-farm jobs

List the main non-farm occupations for older women in order of importance

1	
2	
3	
4	

7. Young women in farming [tick]

	None	**Few /some < 25%**	**About half**	**most > 75%**	**almost all / all; > 90%**
farming full-time					
farming plus other jobs					
not farming					
fuelwood coll.					
Water collect.					
Waste management					

8. Young women: non-farm jobs

List the main non-farm occupations for young women in order of importance

1	
2	

3	
4	

Job Location

9. Where do people work? *[tick]*

	None	**Few/some <25%**	**About half**	**Most >75%**	**Almost all / all; >90%**
Work in village					
Work in Kumasi					
Work in other nearby town – give name(s)					
Work in distant areas					

Commercial & other enterprises in Village

10. Enterprises in village

Enterprise	**Number in village**
Commercial cement block making	
Corn mill	
Gari processing (mechanised)	
Oil palm extraction (mechanised)	
Other factories (specify)	
Other large commercial (specify)	

Section G Agriculture

Crops

1. How many farmers grow the following crops? *[tick]*

	none	**few/ some**	**about half**	**most**	**almost all /all**	**Importance** *[specify major or minor crop]*
cassava						
plantain						
cocoyam						
maize						
yam						
rice						
water cocoyam						
sugar cane						
tomato						
garden eggs						
okro						
chilli pepper						
onion						
cabbage, carrot, lettuce, cauliflower						
other leafy vegetables						
oil palm						
citrus, fruit trees						
cocoa						
coffee						
coconut						
wood lots						
other *[specify]*						

2. How many farmers in the village use the following inputs? *[tick]*

Input	**none**	**few/some**	**about half**	**most**	**almost all/ all**
Chemical fertiliser					
Poultry manure					
Sheep/goat manure					
Cattle manure					
Black soil from tips					
Compost					
Insecticides (DDT,poison)					
Fungicides (powder)					
Weedicide					
Water pump					
Tractor					

3. How many villagers keep the following livestock or catch the relevant wild fish and animals? *[tick]*

Livestock	**none**	**few/ some**	**about half**	**most**	**almost all /all**	**No. of large commercial farms**
Poultry						(> 500 birds)
Sheep						(> 20 sheep)
Goats						(> 20 goat)
Pigs						(> 20 pigs)
Cattle						(> 10 cattle)
Fish ponds						
Fishing (from streams, rivers)						
Bush meat						

4. Any major changes in farming systems in the village since 1983?

_____

_____

Notes for Interviewers on Watersheds Village Characterisation Survey

1. The completeness and accuracy of the information collected is very important, otherwise we will not be able to compare across different villages properly and analyse the data. Care has to be taken when filling in the questionnaire.

2. Follow accepted protocol in the villages and explain the objectives of the study to all your informants. Ensure people know that you are researchers from UST, so that they do not misunderstand the reasons for your visit. Take care not to raise interviewees' expectations of substantial and rapid changes to their lives as a result of this project.

3. *Talking to the right person*: try to ask the most appropriate person for the required information. For example, women are more likely to know where they obtain their cooking fuel or do the washing, so ask them; a wealthy man with a private car may not be a good informant on public transport but may be knowledgeable about commercial developments. You will need to talk to several people to collect all the information. Apart from the Chief or elders and Town Development Committee members, try going to gathering places in the village, such as the market where there should be several people you can ask.

4. *Cross-checking*: do not obtain all your information from one person, however knowledgeable he/she seems, without cross-checking it with others. Be especially careful with information about prices.

5. *Observation*: walk through the village and look around. You will be able to observe such things as the presence of a daily market, post office and electricity, location of refuse dumps. If you are not sure about new housing construction, then go to the new residential areas and look yourself.

6. The proportions of villagers involved is divided into the following categories:

1	none	-	none
2	few/some	-	less than approximately one quarter
3	half	-	about half
4	most	-	significantly more than half
5	almost all/all	-	at least 90% or more

The interviewers should not try to get exact percentages (as the respondents may make a complete guess), as long as they can allocate the answers to one of these categories.

7. The interviewers will need to look carefully at the questionnaire so they take note of where just a tick is required in the tables, or whether more information (eg. Number, place name or proportion) is required. The table column headings plus the guides printed in italic on the questionnaire inform the interviewer of what to write. For example, *[tick]* or *[specify none, few, half, most, all]*.

8. The questionnaire is divided into 7 sections, and the questions can be asked in any order, as long as the questionnaire is finally completed.

9. Compare your answers with the other enumerators before you leave the village. If there are any discrepancies, you can check them straight away with other informants before you leave. This is much easier than having to return to the village later because some information is missing or unclear.

Possible topics for inclusion in discussion with villagers

Water courses and drainage
Identify with villagers the location of water courses and sources in village area
Where do the streams come from and go to
Any flooding and drainage problems and reasons for this
Variation in water quantity and quality over the year
Land use adjacent to water courses and effects of these
Protection of water courses – including taboos, district rules, local village rules
Any known pollution problems of water courses
Do villagers cultivate right to the banks of rivers & streams?

Drinking water
Alternative sources of drinking water
How much does it cost?
Who can afford to pay what?
Is quality of drinking water a problem?
Who suffers most from poor drinking water? Why? What are the effects?
Are any water treatment/purification measures used in the village? If so, what?
Are there any abandoned wells/boreholes in and around the village? If yes, when were they abandoned, and why?

Irrigation
Who has access to valley bottom farms? (men, women?)
What methods of controlling water are there - to prevent waterlogging and for irrigation?
Who uses irrigation or drainage methods? Why?

Water disputes
Are there disputes over water within the village, or between villages? Why?

Waste Processing
What happens to waste water?
Where are refuse dumps located and how are they managed?
Where are latrines located and how are they managed?
What are the effects of new housing on waste management?

Institutional structures
Is there any support, linkages, regulation, interference by outside institutions in water management? Eg. GWSC, WATSAN group formation, District officials, MoFA.

Appendix E: Specifications for Leaflets Evaluation

DFID-Project R7330

Bright Asare Boadi: Scope of Required Evaluation of CEDEP Leaflets Produced for the Project

3,000 produced in English and 3,000 in Twi, in Feb 2000.

We need to know:

1. How many were distributed, to whom, and for what uses?

   KNG was principal distributor – gave to GOAN, CEDEP, IRNR, other partners; some distributed in 'our' 8 villages, including to the schools engaged in water testing;
   GOAN is distributing them more widely in other areas of Ashanti and beyond, within its farmers' networks.
   CEDEP was using Twi ones in adult literacy classes (= Development
   Clubs?)

   Some were also distributed at Feb 2000 workshop, and Mar 2001 workshop & maybe other conferences. We will not get exact figures for numbers distributed – but at least some approximation would be good. Are any leaflets still in stock?

2. Were they used for the expected purposes (including literacy classes), or others too? Which categories of people (e.g. JSS pupils; cubs/scouts/girl guides; adult language learners; organic farmers; communities at large) used them?

3. How effective have the leaflets been? And how do we/they know that? In other words, what is the evidence? Is there any documentary evidence, or only the opinions of the instructors?
   - need to discuss with all users/distributors of leaflets.

4. Were the design and format conducive/appropriate to the tasks? In other words, did users and instructors like:
   - the cartoon style
   - the way the message was explored and explained
   - the size, layout and number of pages?

   Would these people like to have different leaflets in this format in future, or would they prefer different format(s)? If the latter, what other formats?

   For example, how would respondents react to large wall posters to convey the same or similar messages? In cartoon format, or in pictoral format, or just a few key words and ideas, with a diagram?

5. Was there any difference in the use and usefulness of the English and Twi language editions?

   - in particular, we are interested in whether it was worthwhile to have the leaflets translated and produced in Twi. The principal reason for doing this was Tony Dogbe's enthusiasm to use the Twi version in the adult literacy/development clubs, as a way of getting environmental messages across in an indirect way as part of language learning.

6. Did the teachers or instructors use any other documents, books or sources alongside the leaflets to enhance or to elaborate on the message of the leaflets? If so, what? (Get details)

DS/BAB 10/7/01
Leafletevalspec.doc

Appendix F

Schools Test Kit: Follow-up Interviews APRIL 2001

Priority task - schedule for April and May.
1. Questionnaires drafted and copied by mid-April
2. Pilot in one community completed by end-April
3. Completed report by end-May
4. Copies made of raw data, Express Post to Duncan McGregor at end-May

Aim
The aim here is to find out
what the various groups within the Community know about the Schools Test Kit project
whether they understand the rationale for the test kits
what their views are on whether this is a good thing or not
and whether it is (or is not) likely to change their attitudes and/or practices.
whether the testing could be sustainable beyond the lifetime of the Project.

It is meant to lead on from the earlier questionnaire (September 2000), which was only given to the teachers, and was more concerned with the technical operation, etc, of the kit. Cross-checking will be needed, to ensure that there is minimal overlap between the two questionnaires, or where such overlap exists, the reason for it is clearly explained.

As drafted below, there would be separate, but linked, interviews/questionnaire activity for each of the Groups outlined. Are these the right Groups? Are there any important omissions here?

Personnel and Budget considerations

1. Can we rejig the existing schedule for BQAB/SE/VAG to incorporate some or all of this work?
2. How many intereviews?
3. How many communities is it feasible to cover?
4. How much contact time is involved?
5. for DFMM - how to fund this - from existing resources, or do we need additional resources?

1. School children

1. how many children to choose for interview?
2. individual or group interviews? or BOTH individual and group?
   problem here is COST - it might be necessary just to have a single interview with the group most closely involved
3. how many of the five schools to choose, or survey all five schools
4. could this be done via a written questionnaire, perhaps followed up by a group interview, to pick out specific points?

GENDER: must ensure that equal numbers of boys and girls are chosen

2. Teachers and Head Teachers

1. all those involved should be interviewed, or a questionnaire given out and collected later
2. should the head teachers be interviewed/given a questionnaire separately from the teachers?

cross-check earlier questionnaire to ensure no undue overlap (though that questionnaire was more concerned with how the kits were working and what technical problems were encountered)

3. should we offer a small fee for completing the questionnaire?

4. or make a small donation to school funds?

2a. Head Teachers only

Do we need a short, but separate, questionnaire to get the 'official' view

3. Parents
1. how to select parents?
2. how many to select?
3. in which communities, or all 6 involved?
4. problem of Ambabame No1 and Asago: concentrate on Asago, but possibly meet with community at Ampabame to explain why they are not involved (could there be some minor liaison with project activities at Asago -or is this a complication we should avoid?)

4. Community Representatives
1. Which groups to get information from?
   Chiefs and Elders?
   Queen mothers?
   Unit Committees and Watsan Committees

5. Longer term
There will need to be a follow-up in October/November, to see if any changes in practices and attitudes show up as a result of PAMP activities

What SCALE should that be - same as this (financial implications)

Possible Questions for schoolchildren

1. Do you understand why you are using the water quality test kit?
2. Why is it a good thing to use a kit like this?
3. What did you find easy to use and understand? (2 separate questions?)
4. What did you find difficult to use and understand? (2 separate questions?)
5. Have you changed your ways of looking at water as a result of your experiments with the kit?
6. If so, list in what ways you have changed your behaviour

*** too 'open' - does this need some specific examples - a 'checklist'?

7. Have you talked to your parents about the kit?

Mother
Father

8. What have you told them?
9. Do you think they understood what you were telling them?
10. Have they discussed your work with other parents?
11. Have your parents talked to the community about the work?
12. Have your parents changed their ways of using water as a result of what you have told them?
13. Do you think that they are using it more wisely?

*** a 'leading question'?

14. If so, list in what ways thay have changed their behaviour.

15. Have you talked to other children about what you are doing?

brothers
sisters
friends

16. Have these children changed their ways of using water as a result of what you have told them?
17. If so, list in what ways thay have changed their behaviour.

18. Have you talked to other adults about what you are doing?

Grandparents
cousins
family friends
community meetings

19. Have these adults changed their ways of using water as a result of what you have told them?
20. If so, list in what ways thay have changed their behaviour.

21. Have you made a presentation to the community about your work?
22. If you have, what did the community say about your presentation?
23. Has the community changed their ways of using water as a result of what you have told them?
24. If so, list in what ways thay have changed their behaviour.

2. Teachers and Head Teachers

Preamble to the questionnaire:
Some of the questions you are being asked are the same or similar to the earlier questionnaire, but this time we are focusing on the use of the new kit, and the wider impressions of the community. So please answer the questions, even if you feel you have answered them already.

Possible Questions
1. With which class are you using the test kit, and how old are the majority of the pupils?
2. How many children are involved? an entire class or a selection?
3. How did you select the participating children?
4. What have the children found easy to understand about the 'technical' use of the kit?
5. What have they found difficult to understand about the 'technical' use of the kit?
6. Are boys and girls different in their understanding of the technical aspects of using the kit? Please elaborate on your response.
7. Are boys and girls different in their ability to use it? Please elaborate on your response.

[nb: this question was in the earlier questionnaire, but more structured questions would get us more feedback on this]

8. What have they found easy to understand about the reasons as to why water testing is a good thing?
9. What have they found difficult to understand about the reasons as to why water testing is a good thing?
10. Are boys and girls different in their understanding of the reasons for using water testing procedures? Please elaborate on your response.

11. Have you used the kit to help you in the formal parts of the syllabus? Please elaborate on the uses you have made of it.
12. Have you been able to fit the extra work associated with the use of the kit into the timetable easily or with difficulty?
13. Have you used the kit within the context of a 'Science Club' or similar extra-curricular activity?
14. What progress have you made in taking the knowledge obtained by using the kit into the community? yourself? through the pupils? Please elaborate on the type of activity used: children's play, meeting with Parent-Teachers Association, Unit Committee/Watsan, meeting with chiefs and elders of the community, etc

[could make a checklist out of this, leaving space for comments]

15. What message did you carry to the community?
16. How was your message received?
17. Were there any noticeable differences between the interest shown by males and females?
18. Has there been any evidence that people have changed their behaviour as a result of your activities?

19. If so, what changes in behaviour have you noted?
20. Is there any difference in response and behaviour between males and females?
21. Is there any difference in response and behaviour between young people and old people?

Head Teachers only

1. In your opinion, has the test kit been an asset to the school in a wider sense (and not just concerned with the water quality project itself)?
2. Has this been too demanding of teachers' time, or have the teachers been able to integrate the project work into the timetable without undue extra work?
3. Have any positive benefits arisen so far for the school from the community as a result of the project?
4. Have you discussed the project with your District Education Office?
5. If so, have they been fully supportive; have they offered qualified support; or have they not been supportive?
6. Please give details of any reservations they have expressed.
7. Would they be prepared to provide any funding to continue with the use of the kits beyond the project (12 months from now).
8. Have they or you considered setting up a 'Science Education Centre' in the District, perhaps using the test kits as one of the educational tools involved?

3. Parents: possible questions

1. Are you aware of the schools water quality project?
2. Have your children talked to you about the water quality test kit?

Mother
Father

3. What have they told you?
4. Did you understand what they were telling you?
5. Have you discussed their work with other parents?
6. Have you talked to the community about the work?
7. Have you changed your ways of using water as a result of what they have told you?
8. If so, list in what ways you have changed what you do.

9. Have the children or the school made a presentation to the community about their work?
10. If so, what did you think about the presentation?
11. Are you likely to change your personal habits as a result of the presentation?

12. What did the community think about the presentation?
13. Has the community changed its ways of using water as a result of the presentation?
14. If so, list in what ways they have changed their behaviour.

15. Do you feel that you can make a personal contribution to protecting water resources?
16. If so, list in what ways you might do this?
17. Do you think that this should only be the responsibility of the community?

4. The Community: possible questions

a) Chiefs, Elders, Queen Mothers

b) Unit Committee/Watsan Committee

1. Are you aware of the schools water quality project?
2. Have the children talked to you about the water quality test kit?
3. Have the teachers talked to you about the project?
4. What have they told you?
5. Has the work been discussed in a formal community meeting?
6. Has the community changed its ways of using water as a result of what they have told you?
7. If so, list in what ways you have changed what you do.

8. Have the children or the school made a presentation to the community about their work?
9. If so, what did you think about the presentation?
10. Are you likely to change your personal habits as a result of the presentation?

11. What did the community think about the presentation?
12. Has the community changed its ways of using water as a result of the presentation?
13. If so, list in what ways they have changed their behaviour.

14. Do you feel that you can make a personal contribution to protecting water resources?
15. If so, list in what ways you might do this.

Appendix I **Project Bibliography**

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Datasets and software applications

New datasets held in the KUMINFO GIS include:

Water quality (2-year record) in streams around Kumasi

Water-related village characterisation survey

Recorded boreholes and hand-dug wells in peri-urban Kumasi area

Registered plot layouts for selected areas of peri-urban Kumasi

Industry locations and environmental 'hotspots'

Directory of environmental organisations and individuals operational in Kumasi
Bibliography of NRM-related literature, peri-urban Kumasi and related topics

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Appendix J

The KUMINFO Geographical Information System: Business Plan, August 20020

Institute of Renewable Natural Resources
Kwame Nkrumah University of Science and Technology, Kumasi, Ghana

1. INTRODUCTION

Geographical Information System (GIS) is a system of hardware, software, and procedures for the capture, storage, retrieval, analysis and dissemination of spatial data. Data in GIS is usually organised into thematic layers and the ultimate goal of GIS is to simplify and scale observations of real world into graphical elements, to which are related descriptive features termed attributes. The attributes are maintained in a Database Management System (DBMS) while the graphical elements are stored as one of two general types of spatial structures namely raster (grid) or vector (points, lines or polygons).

KUMINFO is a Geographic Information System (GIS), which allows users to generate, interrogate and analyse map and output data related to Ghana in general and the Kumasi area in particular.

KUMINFO was setup in 1997 with funding from the UK Department For International Development (DFID) - formerly the ODA, through DFID's Natural Resources Systems Programme - Peri-Urban Interface Production System. KUMINFO has found a happy home at the IRNR, which provides an air-conditioned premises and modest staff time. The Peri-Urban Interface Production System was originally linked to the DFID project 86799, Kumasi Natural Resources Management Programme (March 1997 to March 2000), which focussed principally on natural resource management in the peri-urban area around the city of Kumasi. Funding has now been extended from 1 April 2000 to 31 March 2002 as part of DFID-funded project 87330, Peri-Urban Natural Resources Management at the Watershed Level, Kumasi, Ghana, with the stipulation that KUMINFO becomes selfsustaining by the end of this period. Accordingly, KUMINFO is now seeking to develop the means of ensuring its longer- term continuance and financial viability.

What can KUMINFO do?
KUMINFO is intended to improve the efficiency of data gathering and to maximise the use of a wide variety of information available in a range of formats for the Kumasi region. KUMINFO provides a way of interpreting data for different map projections at national, regional, citywide and locality-specific scales. Facilities to construct a map, add new data to a map, query the data, construct new data sets and analyse results are all available within the system. Opportunities to combine datasets of different kinds add value to their interpretation and thus save time and money.

KUMINFO is updated regularly, with new census, survey and other relevant secondary and primary data. It is anticipated that organisations, which utilise KUMINFO, will donate further datasets.

Outputs from KUMINFO
The data held in KUMINFO can be presented in many different ways, as maps, images; text files, tables, graphs, histograms and pie charts. These formats are all related and available directly within KUMINFO. A detailed knowledge of computers is not necessary to operate the system.

Future of KUMINFO
For sustainability, the office should be able to generate enough funds to cover its operating costs (including maintenance and the employment of dedicated personnel) the replacement of equipments and appropriate software upgrades. In this light, the office must assume a more commercial orientation. Policies and structures must be put in place to support the office for jobs sourcing and execution. With the additional hardware and software currently being installed, KUMINFO will have the technical capacity to carry out income-generating ventures effectively during and beyond the current 2-year period of DFID funding and to become self-sustaining thereafter. Indeed, this is the main objective of this business plan.

2. MARKET RESEARCH

Directed market research is urgently required into the following:

- Investigation of the full range of potential users.
- Investigation of what types of products are in demand.
- Investigation of what products (including possible competitor services) are available at present, their source and cost.
- Investigation of what price potential clients are prepared to pay for the range of products.
- Investigation of what it will cost to produce outputs, both singly and in bulk (including staff time, overhead costs of the laboratory, production materials, etc).
- Research into what constitutes an appropriate profit margin - to ensure longer-term rolling replacement and updating of hardware and software.

The potential client base should include central, regional and local authorities and Institutions (line ministries and the RCC, KMA and sub-metro councils, District Assemblies, Town and Country Planning Dept., Unit Committees and WATSANs); government agencies and parastatals (e.g. EPA, GWC, Ghana Telecom); private companies of all sizes; NGOs (e.g. CEDEP, GOAN, ISODEC, Trend, Friends of Rivers and Water Bodies); and foreign donor organisations and international NGOs (e.g. DFID, DANIDA, SIDA, NORAD, FINNIDA, CIDA, USAID, EU).

As a means of attracting clients a set of demonstration materials could be produced. For example develop and manage a database for KNUST.

3. COMMERCIAL ACTIVITIES

A range of GIS related services, including consultancy, training, data services and application development could be offered to potential clients. Some of the products and services that could be offered for a fee include-

- Develop and maintain a Geo-Spatial database for Kumasi and its environs.
- Build customised databases for interested resource managers.
- Collaborate in capacity building for other research projects.
- Geophysical analysis and modelling of the 1997 ADP for commercial use.
- Field data can be coupled with the ADP to form Geo-Spatial database for Kumasi. This would be sold to the transport and Utility services providers for proper planning and maintenance.
- Ad hoc specialist advice and consultancy services can be offered to interested parties.
- Maps (roads, utility lines, thematic data etc) could be produced and sold to tourist, institutions and other interested bodies.
- Geophysical analysis and modelling for change detection, monitoring and inventory could be undertaken for interested clients.

4. PROFESSIONAL AND ACADEMIC TRAINING

It is important for clients and users to have a broad overview of the software as well as a thorough understanding of those aspects of KUMINFO and GIS in general that are relevant to their areas of expertise in order to gain the greatest benefit. To meet this requirement:

- Training programmes/workshops, short courses and capacity building would be used to develop an Asahnti Region Tourist map, a Kumasi Metropolitan map, and a three-yerar calendar showing major cultural activities and other social events of the region.
- Undergraduate and Masters level courses or modules could be developed in image processing, GIS and the use of GPS and taught to KNUSAT students (IRNR and Geodetic Engineering).

5. SOME SPECIFIC BUSINESS PLAN ACTIVITIES

1. MAP development
The KUMINFO and In Concert laboratory facilities would be used to develop an Ashanti Region Tourist map, a Kumasi Metropolitan map, and a three-year calendar showing major cultural activities and other social events of the region.

2. Proposal to the Medical School project
Using the ADPs of the Kumasi Peri Urban and the other digital maps available from the GERM project, KUMINFO could be used to produce spatial data bases with attributes that . will be most useful to a medical project that has its own funding. It is proposed that the KUMINFO project should write a proposal for the funding of this mapping project. This will look at diseases of the teaching hospital, data on the patients as to where they live, the environmental situations including the level of sanitation. The relationship to disease prevalence and other data that could be made spatial with corresponding attributes interesting to the researchers of the Medical school will be mapped out.

3. Consumables and Upgrades
It is hoped that money generated will be used to build up facilities and particularly replenish the consumables. The consumables that will be depleted as we go commercial will include laminating paper, ink software and hardware upgrades etc

Materials that would be purchased would include Town sheets of Ashanti Aerial photo of Ashanti, orthophoto maps if available, Digital topo sheets especially for the gaps

4. Internet accesses and telephone access.
The telephone system for the campus is improving and as part of the business plan it is hoped to improve the communication links. It should be possible to acquire a fax machine now to be able to take full advantage when telephone access improves.

5. Other activities
- Wall charts to be printed for the KUMINFO room to enhance advertisement of the facilities.
- One-day workshop for academic staff (introduction to Remote Sensing, GPS and GIS). notes for the workshop are ready.
- Three day workshop for hands-on training. This will attract 1,200,000 cedis per head
- Long term workshops for full individual/group training facilitating purchase of software. 6-8 weeks.
- Student undergraduate/postgraduate training for research and taught courses. This is already on board and will be intensified. This may not attract charges except for sponsored students. However students will be required to provide diskettes and paper support.
- Trips to Accra, Cape Coast and Sunyani to advertise KUMINFO capacity using brochures and maps developed as portfolios.

6. COSTING POLICY

Costing would be based on what is affordable to clients with differential fees for commercial versus non-commercial. Charities/aid users would also be considered. Possibly there would be three fee categories along the following lines:

Suggested high-price category
International commercial firms, agencies
National enterprises
International NGOs
International donor agencies

Suggested medium-price category
Local government: KMA, District Assemblies, District Planning Offices, Area Committees. Local enterprises/contractors and local technical/service NGOs. Universities, Colleges. DFID projects (for the present).

Suggested low-price or cost-price category
Community agencies such as Unit Committees, WATSAN Communities. Schools. Genuine community based organisations (CBOs).

Technical Appendices

1. KUMINFO INTERFACES

KUMINFO allows access to several interfaces based on either general geographical regions or on research issues covered in the Kumasi Natural Resources

Management Research Project (KNRMRP) or the Research into Peri-Urban Natural Resources at the Watershed Level (Kumasi watersheds) project.

General interfaces

Ghana (geographic co-ordinates)

GhanaGNG (Ghana National Grid)

Kumasi (geographic co-ordinates)

KumasiGNG (Ghana National Grid)

Research interfaces

VCS (Village Characterisation Survey: -geographic co-ordinates)

Mapping (Village Land Use Mapping Studies: - GNG)

PRA (Participatory Rural Appraisal Studies: - geographic co-ordinates)

Planning (District Level Planning: - GNG)

Watershed management (under construction - GNG)

Urban footprint: - (geographic co-ordinates)

Data from the following studies can be accessed through Kumasi interface:

Urban agriculture general studies.

Detailed studies on agriculture in urban gaps.

Interfaces developed recently

Bibliography of Natural Resource Management literature for Kumasi and environs

Directory of Environmental Resource Institutions and Contact Persons in Kumasi

Interactive Catalogue of Water Quality data, peri-urban Kumasi

Interactive Catalogue of Boreholes and Hand-Dug Wells, peri-urban Kumasi.

2. KUMINFO SPECIFICATIONS AND CAPABILITY

Hardware
1 Computer System (Pentium III, 700MHz, 256MB Ram, 20GB)

CD ROM/Writer, Jaz Drive

Support Hardware Units
Two Prototype Systems Running Windows NT 4.0
Pentium II (200MHz), 64MB Ram, 5.5GB Rom
3.5" Floppy Diskette, CD Rom, CD Writer
21" Monitor

Accessories
1 A3 Laminator
1 HP ScanJet 6100C
1 A3 HP DeskJet 1120C
2 A4 HP DeskJet
690C Printers
3 UPS

Software
Arcview 3.1
Spatial Analyst 1. 1
Image Analyst 1.1
Smart Image 3.02
Ms Office 97
Paint Shop Pro
Corel Photo
Paint 6