Centre for Research on Environmental Systems and Statistics

Evidence of soil instability and erosion along paths and roads in five villages in Central Ghana

CRES/QA/EROSION/1/0401/1.1

Collaborator: N.A. Chappell

Sub-component of DFID project R7575:
Action research to evaluate the impact on livelihoods of a set of post-harvest interventions in Ghana's off-road settlements: focus on IMTs
(Dr Gina Porter, University of Durham, UK)

Crop Post Harvest Programme

Report on visit 4-9 February 2001

Institute of Environmental and Natural Sciences, Lancaster University, UK

Document Number:	CRES/QA/EROSION/1/0401/1.1
Title:	Evidence of soil instability and erosion along paths and roads in five villages of Central Ghana
Author(s) and affiliation:	N.A. Chappell (CRES)
Date written:	April 2001
Revised:	April 2001

Work carried out for DFID project R7575

	NAME	SIGNATURE	DATE
AUTHOR(S)			
CHECKED			
APPROVED			
APPROVED FOR EXTERNAL DISTRIBUTION			

Centre for Research on Environmental Systems and Statistics
Institute of Environmental and Natural Sciences
University of Lancaster
Lancaster LA1 4YQ

tel: 01524 65201 and fax: 01524 593985

Chappell, N.A., 2001. *Evidence of soil instability and erosion along paths and roads in five villages of Central Ghana*: Report on visit 4-9 February 2001. CRES Technical Report CRES/QA/EROSION/1/0401/1.1, Lancaster University, UK.

Contents

\path1.doc

1. Aims and objectives

Department for International Development (DFID) project R7575 of the Crop Post Harvest Programme is action research on the livelihood impact of 'Intermediate Means of Transport' or IMTs (e.g., bicycles, wheelbarrows, hand-carts, 'push-trucks' power tillers) in Ghana's off-road settlements (Porter, 2000). The study focuses on five villages (i.e., Adabra, Abora, Sampa, Lome and Awurabo) within Ghana's Central Region (Figure 1).

Figure 1. Location of Central Region of Ghana (West Africa), the location of the five study villages.

A small component of this progamme is an assessment of the physical site factors (notably soil problems) that might impact on the successful use of IMTs, or that might result in newly introduced IMTs impacting on existing pedestrian users. This component involves:

(1) A rapid visual assessment of likely soil trafficability problems (i.e., gully development, surface-wash erosion, waterlogging, slipperiness, mass movements, terrain unevenness) along (a) paths between the village and either fields or local markets, and (b) 'feeder roads' maintained by the Department for Feeder Roads, Government of Ghana. Feeder roads are roads engineered from relatively local soil materials (Frempong and Tsidzi, 1999) and not-surfaced with tarmac or concrete. This survey was undertaken by Dr Nick Chappell of the CRES Hydrology and Fluid Dynamics Group, Lancaster University, with considerable assistance from Miss Kathrin Blaufuss and Mr Frank Owusu Acheampong (Research Assistants on DFID R7575) and Dr Gina Porter of the University of Durham, UK (Principal Investigator of DFID R7575). The dominant soil in Ghana is the Acrisol-Alisol group (Driessen and Dudal, 1991), and Nick Chappell was able to use his experience of hydro-geomorphological studies on similar Acrisol-Alisol soils in equatorial Southeast Asia and Southeastern USA. This rapid survey was undertaken during a field-visit from the 4 to 9 February 2001. During this visit brief discussions were undertaken with Ministry of Food and Agriculture (MOFA) staff at Accra (Mr B.M Oppong) and Cape Coast (Mr Patrick A Larbi and Mr Thomas K Anang Siaw), staff of the Geography Department, University of Cape Coast (Prof L.A.Dei), Soil Science Department, University of Ghana at Legon, and DFID project staff at the Department of Feeder Roads, Accra (Oriel Kenny). Further, sites were identified for Kathrin Blaufuss to undertake simple measurements of path and road deterioration over the subsequent 12-15 months. This report details the results of that visit.

(2) Measurements of path and road deterioration over a period of 12-15 months, at locations identified in the report on the visit of the 4-9 February 2001 (this report). Detailed recording of the timing and nature of any repairs undertaken by the community or contractors to the paths and feeder roads. Field sampling and reporting to be undertaken by Kathrin Blaufuss.

(3) A further field-visit by Nick Chappell will be undertaken after 12-15 months (ideally during a wet period) to (a) examine path and road deterioration, in response to prevailing hydro-climatic conditions and new IMT use, (b) give assistance to the interpretation of the hydro-geomorphic data collected by Kathrin Blaufuss, (c) assess sites where new IMTs experienced particular difficulties. A second report will be made following this visit. Assistance will also be give to Kathrin Blaufuss in the preparation of an academic publication on this case study of the interaction between soil instability / erosion and IMT use.

2. Hydro-climatic setting

Most erosion within humid tropics is the result of water erosion during rainstorms (Douglas, 1977). The temporal incidence of rainfall is, therefore, the main determinant of the temporal incidence of erosion, though the relative role of each storm may be dependent on the timing of episodes of terrain disturbance / land-use change (Chappell *et al*., 1999; Douglas *et al*., 1999).

The Ghana Meteorological Services raingauge that is nearest to the study village of Adabra is at Agona Swedru town (05° 31' N, 00° 42' W, height 61 m, No. 0500-066-23), about 9 km South Southwest of Adabra. In 1999, a total of 1,351.7 mm of rainfall was received at this station, mostly within the first of the two monsoons seen within this coastal region of West Africa (Opokuankomah and Cordery, 1994; Adiku and Stone, 1995; Adiku *et al.*, 1997; Figures 2a and 3). Extreme rain-events (i.e., >100 mm/day), that have a disproportionately large effect on erosion and mass movements (Douglas *et al*., 1999), can be seen within the records (Figure 3). Large rainstorms (i.e., 50-100 mm/day) are also expected to lead to measurable gully development and mass movements in areas lacking complete vegetation cover and redouble soils.

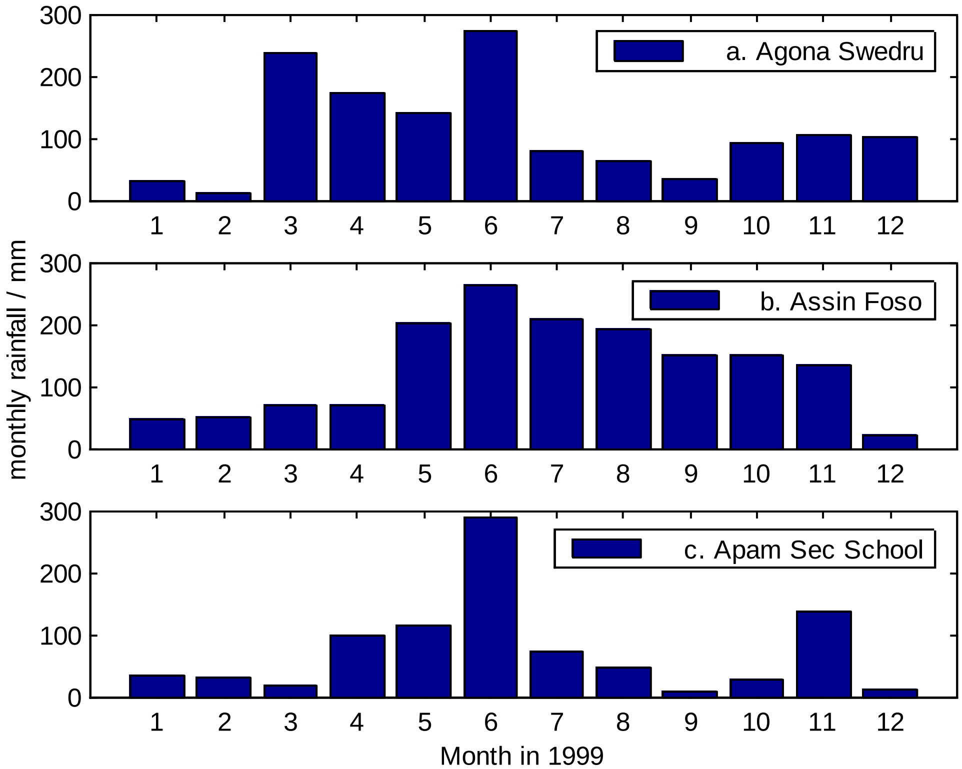

Figure 2. Monthly rainfall totals at three raingauges in Central Region of Ghana in 1999. Data provided by the Ghana Meteorological Service, Accra.

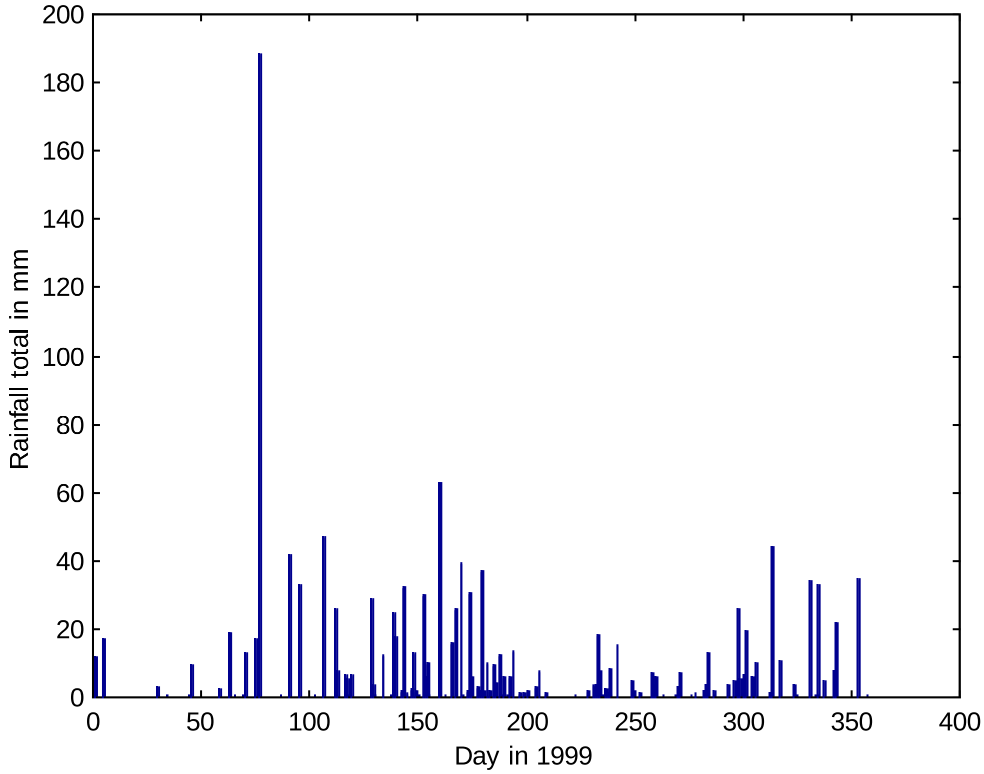

Figure 3. Daily rainfall monitored at Agona Swedru town, Central Region, Ghana in 1999. Data provided by the Ghana Meteorological Service, Accra (\rainfall\swedru.m).

The Ghana Meteorological Services raingauge that is nearest to the second study village, called Awurabo, is at Assin Foso town (05^o 42' N, 01^o 17' W, height 500 m, No. 0501-018-20). In 1999, a total of 1,577.4 mm of rainfall was received at this station (Figure 2b). A Ghana Meteorological Services raingauge at Apam Secondary School, in the coastal town of Apam (05^o 17' N, 00^o 44' W, height 1.5 m, No. 0500-061-23) is relatively close to the three other study villages of Abora, Lome and Sampa, and received 901.9 mm in 1999 (Figure 2c).

3. Results of the visual survey during 4-9 February 2001

3.1. ADABRA VILLAGE

3.1.1. General site and survey details

The village is located at approximately 05^o 34' N, 00^o 34' W in Gomoa District of Central Region, Ghana. A rapid visual survey was undertaken on the 5 February 2001. The local region (Figure 4) has relatively flat terrain with local rounded (tor-like) granite outcrops/hills. Villagers' reports of rainfall on 2 and 4 February 2001, explained the presence wet, wash-materials on road surfaces.

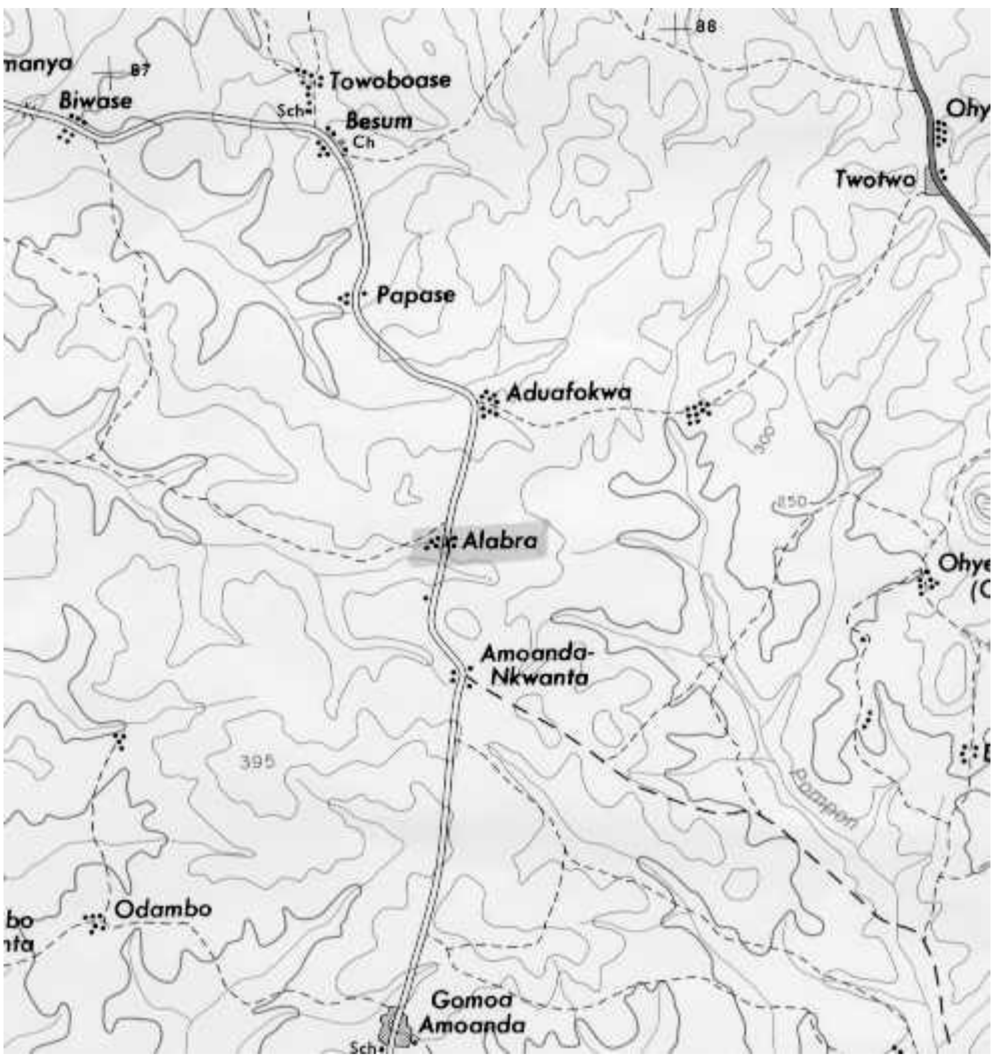

Figure 4. Regional feeder roads (=), topography (-) and some paths (- -) in the vicinity of Adabra village. Adapted from map sheet 0501A4 (1:50,000 scale), Survey of Ghana.

3.1.2. Feeder road to market

The road to the market in Awutu Bereku is 7.4 km in length, and was re-graded in November-December 1999 (Kathrin Blaufuss / Frank Owusu Acheampong, pers comm.). The sand-gravel surface (saprolite) of the road appears to have a silty matrix. This made-surface is at least 0.3 m in depth in places. There is evidence of granite cobbles in the road foundation. The road surface has good camber for drainage, and cut channels for drainage on either side. There is no evidence of breakout or extensive downcutting of these channels, except at a few localised places. Notable exceptions are the road-side channels within the Abora village itself (Figure 5). There is evidence that these channels were recently active. On the Eastern side of the village, there is evidence that field drainage coalesces into small gullies that drain into the road-side channels. To the South of the village (towards Awutu Bereku), the road passes through a valley and then rises steeply up the other side (Figure 5). A shallow, but long gully has developed within this steep road section (Figure 6), and appears to be feeding sediment directly to a pond in the valley, on the upstream side of the road (Figure 7). This pond, one of the water-supplies for Abora village (Blaufuss, pers. comm.), is very turbid. Other steep (>20^{o}) sections of the 7.4 km road to Awutu Bereku have similar shallow gullies developed on their surfaces. Note: The middle section of this road is only shown as a path on the 1:50,000 scale map (sheet 0501A4) published in 1975.

Figure 5. Road-side drain over-deepening due to surficial erosion, Adabra village looking South.

Figure 6. Road gully developed on the slope on the far slope in Figure 5, Adabra village

Figure 7. Turbid pond partly sourced by the road gully shown in Figure 6, Adabra village

3.1.3. Paths

Path 1, which runs West of Adabra towards Okotokwa (Figure 4), is 0.3-0.5 m wide and is covered by sand-textured material (predominantly quartz from weathered granite) (Figure 8). This is no evidence of significant gullying or stream crossings along the first +600 m walked. One section has a depth of loose sand, which may pose difficulties for walking or IMTs, otherwise paths have a compact subsoil. Slopes are relatively shallow ($<10^o$), so widening for IMT use should not pose additional 'cut-and-fill' instability problems (Figure 9). There is no evidence of significant gullying in surrounding fields, though some localised slope-wash may be present. Soils by the path appear sandy, but dark, probably as a result of high levels of organic matter (a positive soil binding agent). The soils around Adabra are mapped as Lixisols (locally 'Adawso-Bawjiai / Nta-Ofin Association'; Adu and Asiamah, 1992). Such soils have a higher base saturation than Acrisols, such as those found at Abora, Sampa, Lome and Awurabo, and as a result are expected to have less erodible soil structures (Deckers *et al.*, 1998), though surface slaking can make them prone to local slope-wash (Driessen and Dudal, 1991).

Figure 8. Loose sand surface of path 1, Adabra village

Figure 9. Flat terrain about Path 1, Adabra village

3.1.4. Summary of key issues

The paths seem relatively stable and capable of being widened for IMT use. Significant IMT damage to these paths is not expected. A few short sections of the feeder road to Awutu Bereku market are relatively steep and may develop gullies over the next few 'wet seasons'. These short sections may add to the effort of transport, but would probably not make the road impassable for IMTs for several years.

3.1.5. Monitoring recommended

Monitor the rate of development of the gully on the feeder road just South of Adabra (Figure 6). Identify the presence of extreme rainfalls in the daily records over the next 12-15 months. Such events would be the most likely cause of any accelerated gully development (Douglas *et al.*, 1999). Use the monitored development of this gully as a semi-quantitative measure of the likely rate of deterioration of other steep road sections along the Adabra-Awutu Bereku feeder road.

3.2. ABORA VILLAGE

3.2.1. General site and survey details

The village is located at approximately 05° 19' N, 00° 46' W in Gomoa District of Central Region, Ghana. The visual survey was undertaken on the 5 February 2001. The local terrain is generally of low relief and has little tree cover (Figures 10 and 14)

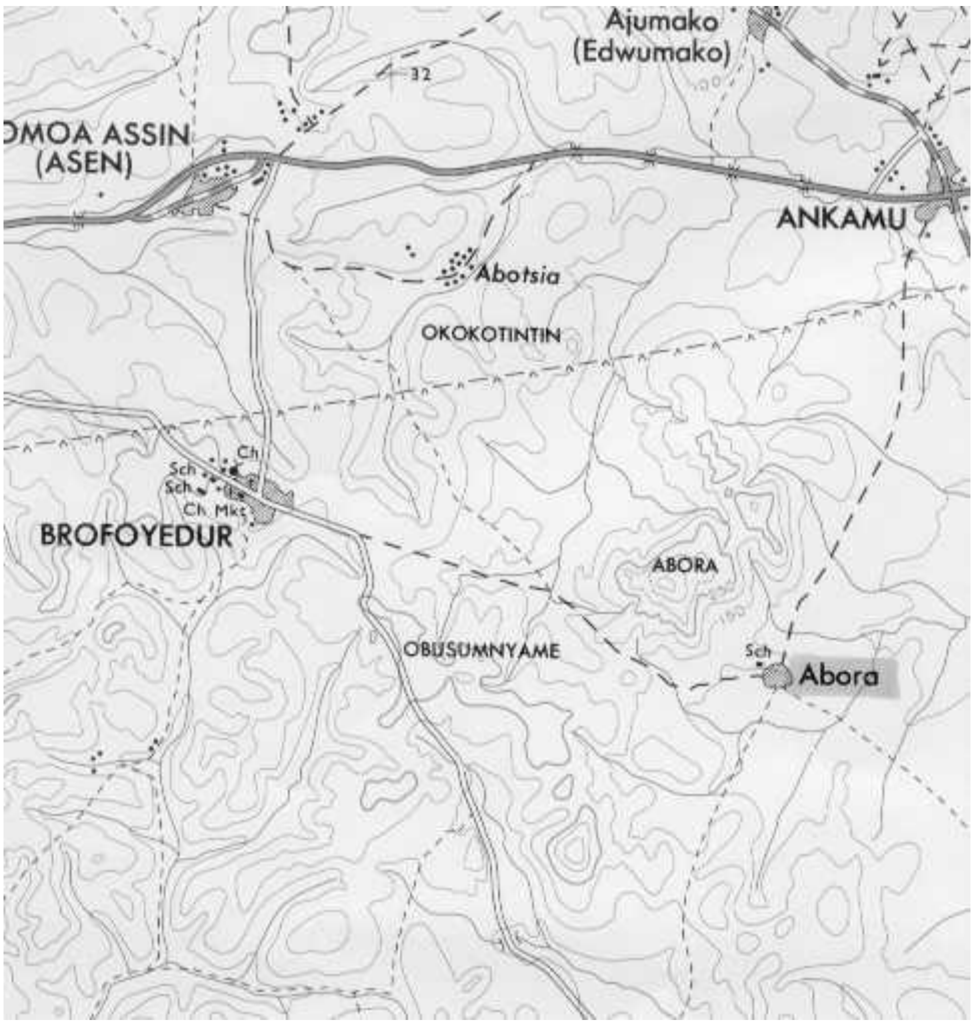

Figure 10. Regional feeder roads (=), topography (-) and some paths (- -) in the vicinity of Abora village. Note that the new feeder from Abora to Ankamu is shown as a path on this old map. Adapted from map sheet 0501C1 (1:50,000 scale), Survey of Ghana.

3.2.2. Feeder road to market

The feeder road connecting Abora village with the market (and source of water) at Ankamu settlement was re-graded in 1997, some culverts were repaired in 2000 (Figure 11), and a section close to Ankamu tarred in early 2001 (Kathrin Blaufuss / Frank Owusu Acheampong, pers comm.).

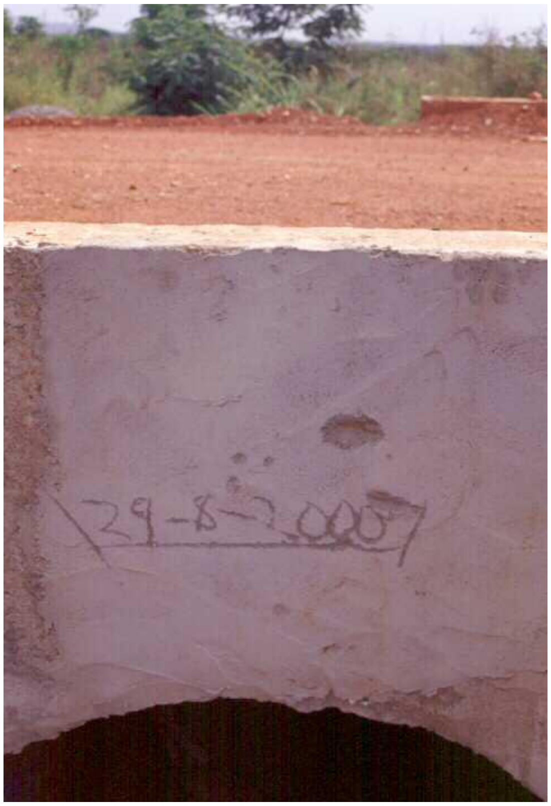

Figure 11. A road culvert along the new Abora-Ankamu feeder road

The likelihood of erosion of the road surface cannot be judged directly, as the road probably has not experienced many large storms since construction. The high rate of localised gullying of the steeper slope of the Eastern part of Abora village (Figure 12), may, however, suggest that the local soils are relatively weak, so that gullying may develop on the steep section of the Abora-Ankamu road, immediately North of Abora. The soils in the immediate vicinity of Abora are mapped as Acrisols (locally 'Bekwai-Nzima / Oda Association'; Asamoa, 1968), the dominant soil of Ghana / Ivory Coast region (Driessen and Dudal, 1991). Such soils are known to be susceptible to erosion, but not as weak as the related Alisols, which are rich in 2:1 clay minerals (Driessen and Dudal, 1991).

Figure 12. Extensive gullying on the Eastern section of Abora village

3.2.3. Paths

Path 1 connects Abora village with fields and with the market at Apam town, some 4.4 km away in a Southeasterly direction (Figure 10). The first 2 km of this path was examined. The start of this path has a small gully (up to 0.4 m deep and 0.4 m wide; Figure 13).

Figure 13. A gully (centre foreground) developed at the start of path 1, Abora village

This gully appears to be fed by the road-side channel East of the new Abora-Ankamu road, and by other gullies running through the Eastern half of Abora village (Figure 12). This gully, probably within Acrisol soils, is likely to offer a significant obstacle to IMT passage. The concentration of surface runoff in this area may also mean that the IMTs have a negative impact on the path surface in this area. The MOFA Village Infrastructure Project (VIP) is to make significant improvements to this footpath in the year 2001 (Thomas K Anang Siaw and Patrick A Larbi, pers. comm.; Siaw, 2000), and so is likely to remedy this local problem. Further along the path, the track lies within a small depression (0.05-0.10 m deep, 0.3 m wide) with a sandy-gravelly surface. There is flat terrain either side of the path, so widening for IMT use should not require any slope cutting. There is one small area of the path where the soil is wet, and probably relates to a small stream crossing the path. I suspect that this would be easily culverted during the VIP path improvements. At approximately 1.5 km from Abora, there is a very flat area (perhaps a shallow depression, Figure 14), with very dark brown soils, that exhibit strong cracking (Figure 15).

Figure 14. Abora village is just below the peak of Abora Hill on the horizon. Photograph taken from the depression containing Vertisol soils.

The dry-season cracking probably indicates the presence of expanding 2:1 lattice clays. These soils are mapped as Vertisol soils (locally 'Osibi-Bumbi Association'; Asamoa, 1968). While there is no evidence of old ruts associated with damage during the wet season, Vertisol soils are likely to become very slippery and waterlogged during the rainy season (once the peds have swollen with the first rains). An elevated causeway (made from soils other than Vertisols) with subsurface drainage may be necessary for successful IMT use during the wet-season. Such a causeway is planned with the VIP improvements.

Figure 15. Cracks within the Vertisol soils along Path 1, Southeast of Abora village

The first 300 m of Path 2, which extends to Brofoyedur village (Figure 10), is on relatively level terrain, shows little evidence of gullying and has a coarse sandy surface.

3.2.4. Summary of key issues

Local gully development and soft ground along Path 1 would probably give problems for IMT use during the wet seasons. This path is, however, to be improved in 2001 as part of the Village Infrastructure Project. The key issue, therefore, is the success of the engineered earthworks in overcoming the local soil problems. If extreme storms (> 100 mm d^{-1}) occur over the next 12-15 months, gullies may develop in the feeder roads close to the village due to the intrinsic weakness of the local materials. Such gullies may hinder IMT use along short sections of the Abora-Ankamu road.

3.2.5. Monitoring recommended

Monitor the engineering works on Path 1, particularly how the surface runoff at (a) the start of the path, and (b) within the Vertisol area, is managed. Note any gullies that develop in the new feeder road.

3.3. SAMPA VILLAGE

3.3.1. General site and survey details

The village is located at approximately 05° 23' N, 00° 51' W in Gomoa District of Central Region, Ghana. The visual survey was undertaken on the 5 February 2001. In comparison to the villages of Adabra and Abora, there is greater topographic relief in the vicinity Sampa village; the village being located on a ridge-top (Figure 16). There is also greater forest cover within this area (e.g., Figure 18).

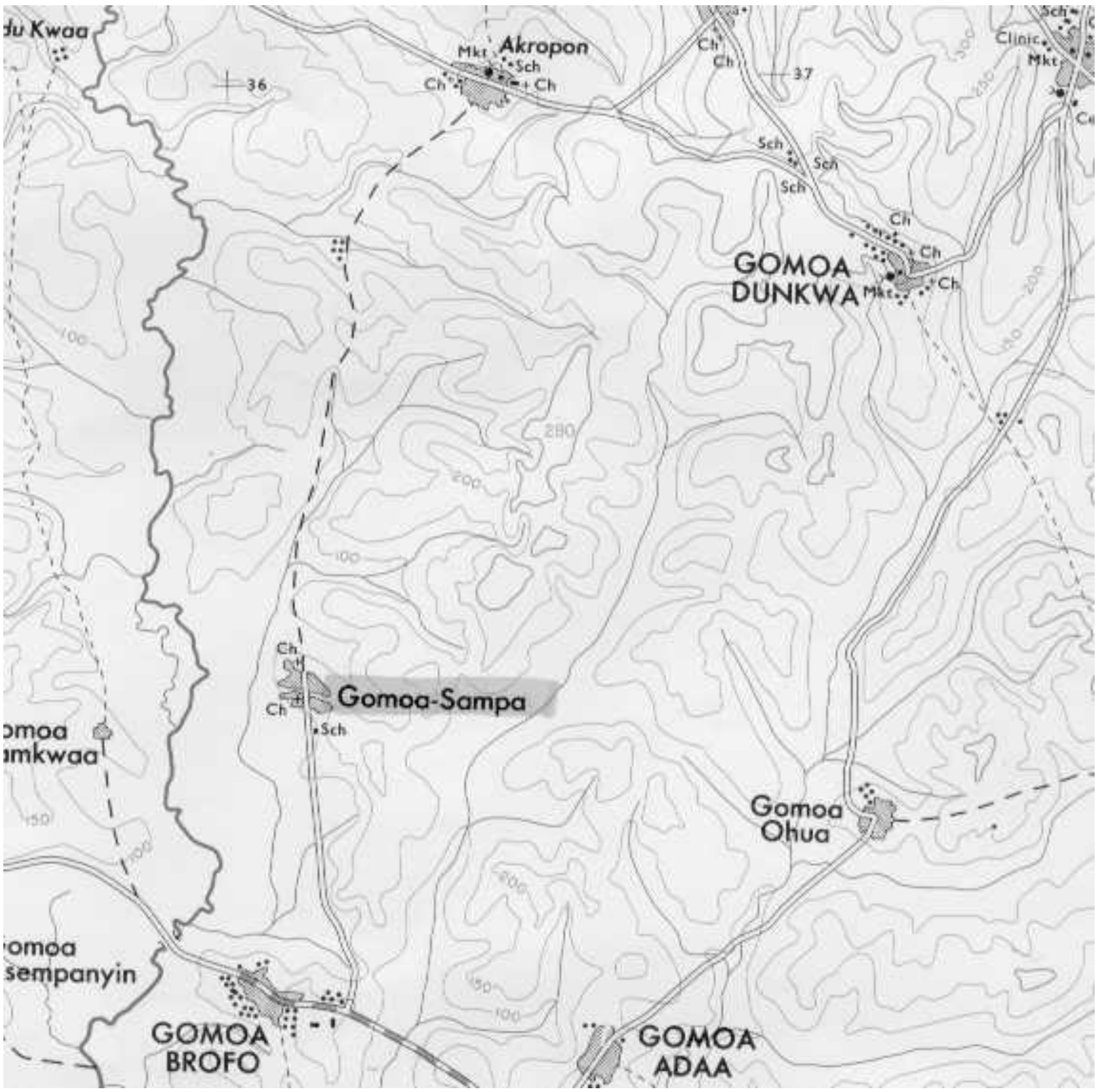

Figure 16. Regional feeder roads (=), topography (-) and some paths (- -) in the vicinity of Sampa village. Note that the feeder road from Sampa to Akropon is only shown as a path on this old map. Adapted from map sheet 0501C1 (1:50,000 scale), Survey of Ghana.

3.3.2. Feeder road to market

The road from Akropon to Brofo village passes through Sampa. This road is in a very good condition, probably as a result of the re-grading in May-June 1998 (Kathrin Blaufuss / Frank Owusu Acheampong, pers comm.). On the very steep section of this road immediately North of Sampa, the Western road-side drainage channel has over-deepened slightly and exposed the underlying bedrock. During extreme rainfall events (e.g., 1 in 5 year recurrence interval) of the wet-seasons, gullying is likely on such steep sections of feeder roads. Along the road to the South of Sampa, several concrete culverts (one dated 1976) were seen to be in good condition. Gully protection works were seen in the grounds of the village school. Cobbles had been placed in gullies to arrest their development (Figure 17).

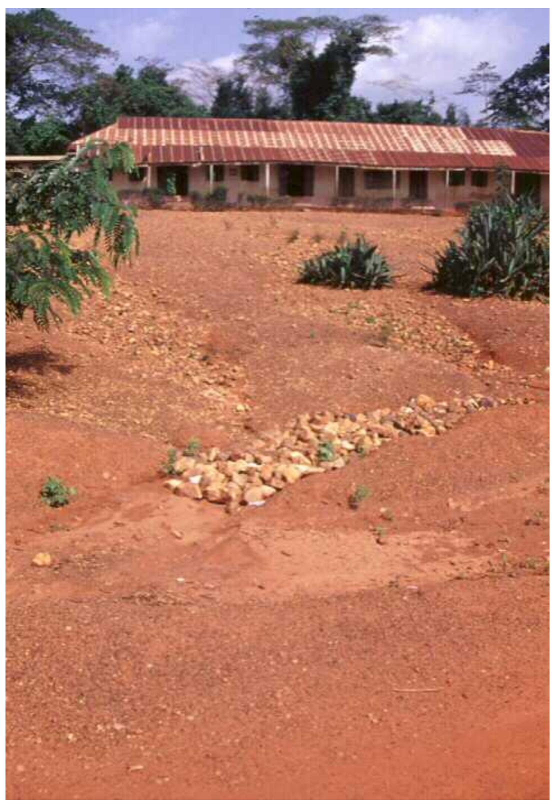

Figure 17. Gully control using rock dams, school grounds, Sampa village

3.3.3. Paths

Path 1 (not shown in Figure 16) descends steeply (ca. 30^{o}) out of Sampa village in a Northwesterly direction to the River Okye and beyond. This path is used in the collection of water from the River Okye and for access to fields. The first section of this path has a gully in excess of 100 m in length (Figure 18), and fed probably by surface flow generated in the Northwestern corner of the village. Sampa lies within the same region of relatively weak Acrisol soils as at Abora (locally 'Bekwai-Nzima / Oda Association'; Asamoa, 1968).

Figure 18. Gully development at the start of path 1, the route to the River Okye (Sampa village)

With further development, this gully would affect the passage of IMTs (see Figure 19), though I suspect that the steepness of the slope makes IMT use already hard work on this section of the Sampa-Okya River path. Below this steep section, the path has a modest gradient and is already wide enough for the use of IMTs. The soils are very dry (< 20 % moisture content by volume), with the exception of one flat area half way to the R. Okya (by the plantain plot). The wetness of the soils in this area allowed estimation of the particle texture, which appeared to be a loam. By the River Okya, the soils were, however, sandy (probably alluvial sands).

Figure 19. A 'push-truck' IMT being delivered at the chief's palace, Sampa village

3.3.4. Summary of key issues

The paths seem relatively stable and capable of supporting the IMTs, with the possible exception of the very steep section of Path 1, as it leaves Sampa. Indeed, the IMTs may exacerbate the gully development if soil conservation measures are not undertaken. The feeder road in this locality appears relatively stable.

3.3.5. Monitoring recommended

Monitor the growth of the gully at the start of Path 1, and any soil conservation measures undertaken to maintain trafficability.

3.4. LOME VILLAGE

3.4.1. General site and survey details

The village is located at approximately 05° 24' N, 00° 45' W in Gomoa District of Central Region, Ghana. The visual survey was undertaken on the 7 February 2001. In comparison to the villages of Adabra and Abora, there is greater topographic relief (Figure 20) and greater forest cover in the vicinity Lome village.

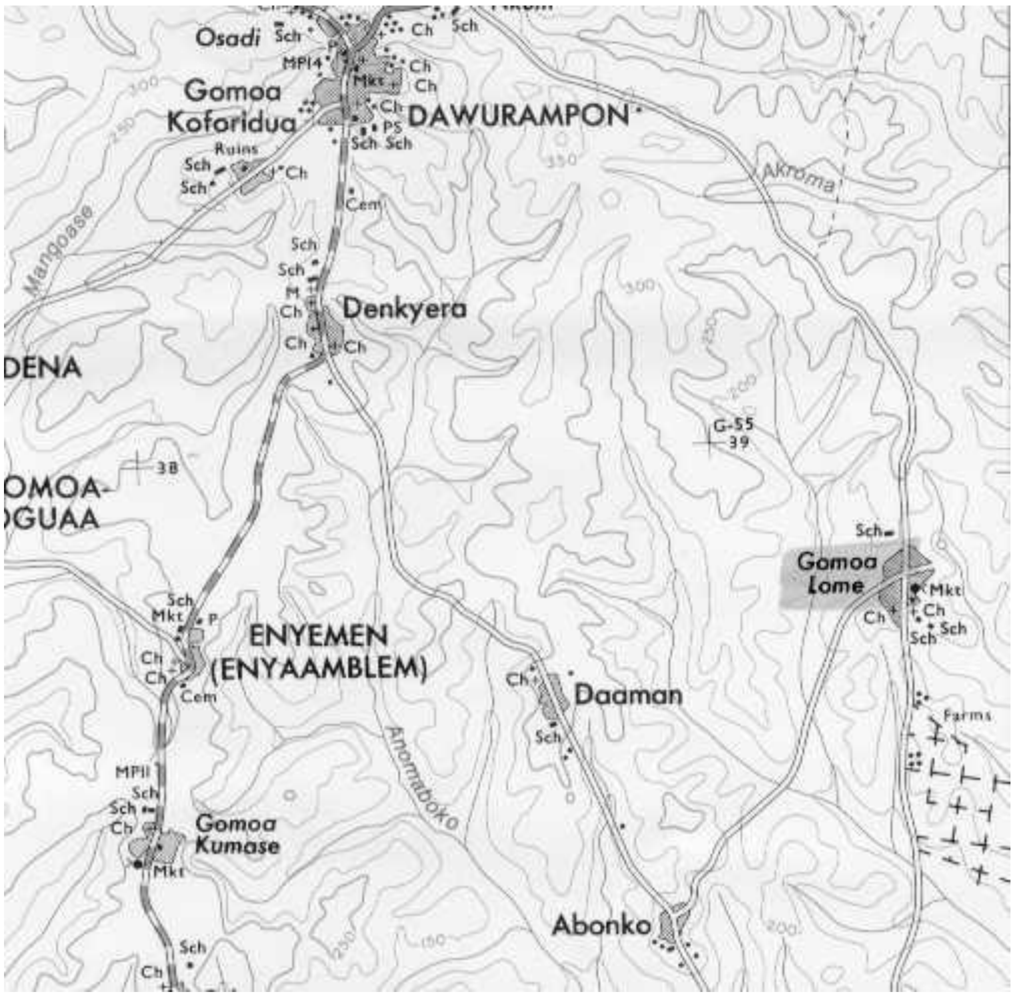

Figure 20. Regional feeder roads (=), topography (-) and some paths (- -) in the vicinity of Lome village. Adapted from map sheet 0501C1 (1:50,000 scale), Survey of Ghana.

3.4.2. Feeder road to market

The feeder road from Lome to Dawurampon town had a very uneven surface in places, indicative of the presence of ruts and very poor trafficability during wet seasons. This road had been re-graded in November-December 1999 (Kathrin Blaufuss / Frank Owusu Acheampong, pers comm.). Close to the village, the road appeared to be in a better condition. This may have been because of the relatively modest slopes, or to small-scale repairs undertaken by the villagers themselves (Figure 21).

Figure 21. A small borrow pit (?), used to repair small road gullies, Lome village

3.4.3. Paths

Path 1 (not shown on Figure 20) is used by the villagers to access fields directly East of Lome, and heads into the Yenku Block A Forest Reserve. The path traverses a very undulating topography, is very narrow and has steep banks either side (Figure 22). Much excavation would be required to widen the path for the use of the 'push-truck' IMTs (Figure 15). There is evidence of some localised gully erosion in the granitic soils on the steeper slope elements. The soil in this region is mapped as a relatively weak Acrisol (locally 'Abonku-Eja / Awuaya-Nkansaku; Asamoa, 1968). The locally steep slopes, heavy pedestrian use of Path 1 (Blaufuss pers. comm.; Porter, 1999) and the Acrisol soil readily explain the presence of gullying.

Path 2 (shown as a feeder road on Figure 20) was widened in November 2000 to allow access to orange groves to the South of Lome (Kathrin Blaufuss / Frank Owusu Acheampong, pers comm.). The track surface looks relatively stable, though the newness of the ground surface may mask evidence of erosion. Indeed photographs taken in 1998 (Gina Porter, pers. comm.), show that this track had a deeply incised gully prior to the re-grading in November 2000.

Path 3 (not shown on Figure 20) goes from Lome in a Southeasterly direction to fields and then onto Onyadte village. This path becomes very sandy at the edge of the village and remains sandy at least for the several 100 m walked.

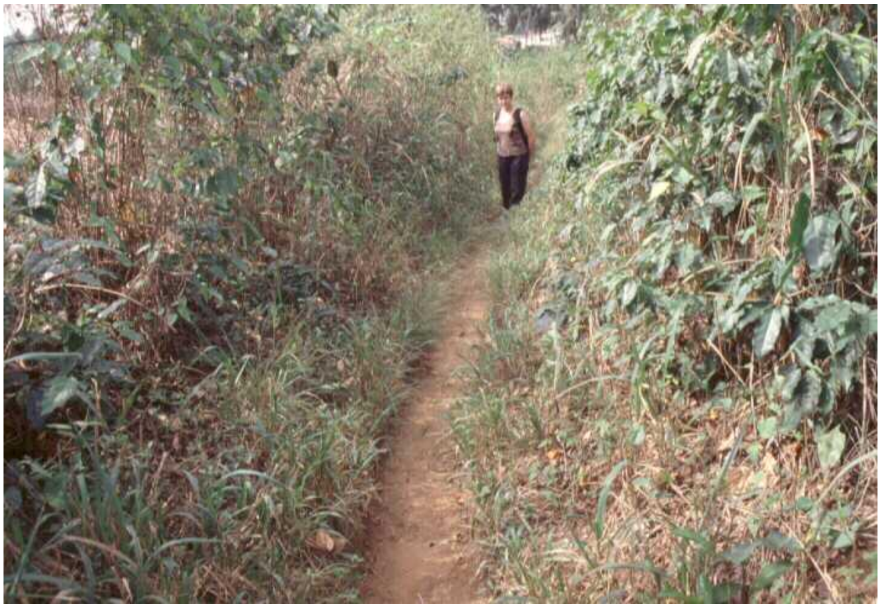

Figure 22. Path 1 (between Lome village and the Yenku Block A Forest Reserve). The narrowness of the path and steep banks either side should be noted

3.4.4. Summary of key issues

The incised nature of Path 1 would make widening for IMT use a significant task. Furthermore, the high local relief may mean that IMT use significantly increases soil mobilisation. Existing pedestrian traffic, as well as new IMT traffic, may be negatively affected by the use of wheeled vehicles. The other paths do not seem to suffer from the same risks. Evidence from old ruts indicates that IMT use along the Dawurampon road may become difficult during wet seasons.

3.4.5. Monitoring recommended

Record any earthworks activity along Path 1 undertaken for IMT use. Record use of IMTs along the Dawurampon feeder road; when present, note the date and location of any trafficability problems.

3.5. AWURABO VILLAGE

3.5.1. General site and survey details

The village is located at approximately 05^o 53' N, 01^o 12' W in Assin District of Central Region, Ghana. The visual survey was undertaken on the 8 February 2001. The area has an undulating topography (Figure 23) and a high forest cover (located to the Southwest of the Birim Forest Reserve; Figure 24). Cocoa production is important within the disturbed natural forest of this area.

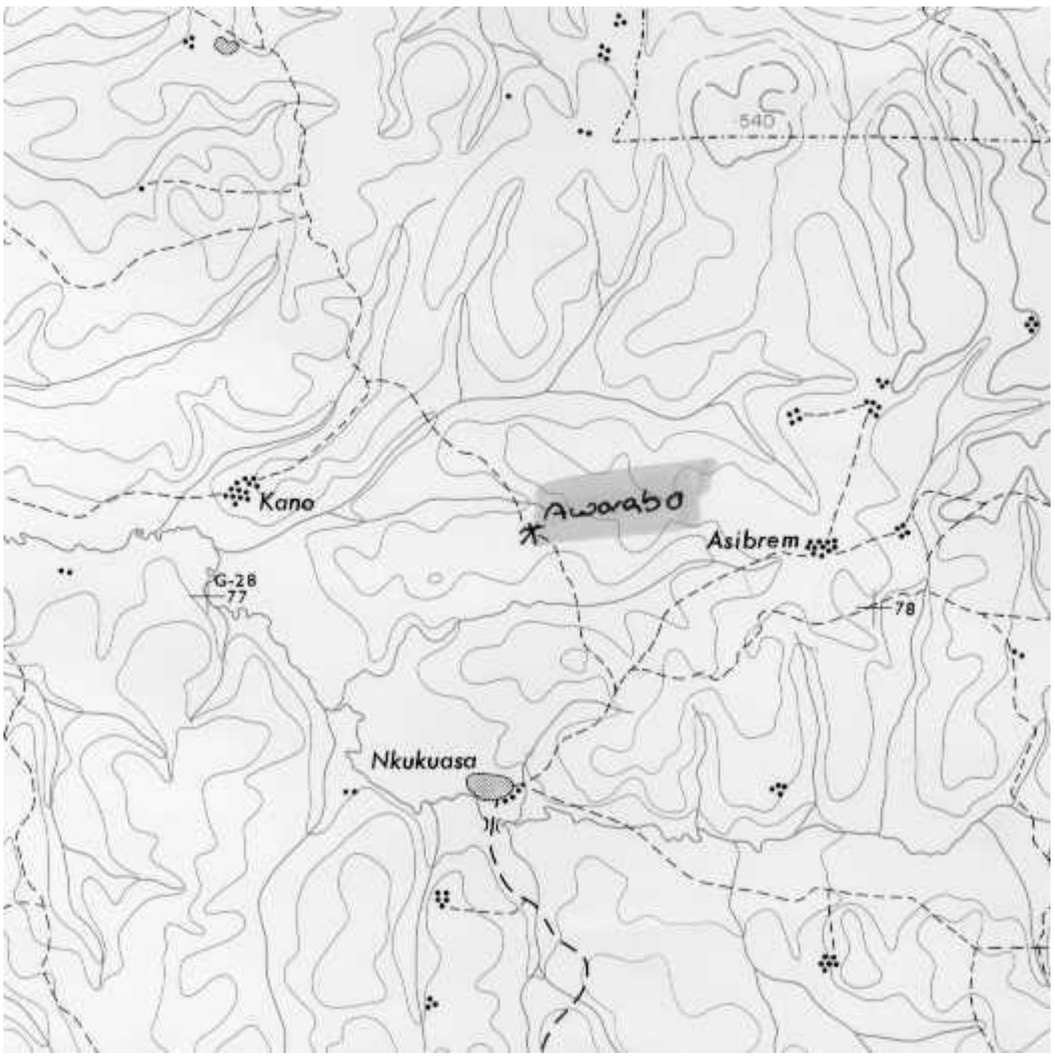

Figure 23. Regional feeder roads (=), topography (-) and some paths (- -) in the vicinity of Awurabo village. Note that the feeder roads to Awurabo, and the paths about Awurabo are more recent than this mid-1970s map. Adapted from map sheet 0502B2 (1:50,000 scale), Survey of Ghana.

3.5.2. Feeder road to market

Neither the feeder roads or the village itself are shown on the 1:50,000 map (sheet 0502B2) produced in 1974/5. In places the local feeder roads have a very uneven surface indicating severe trafficability problems during wet seasons. Mud has been splashed to great heights onto the road-side vegetation, probably indicting heavy use of the road by lorries (perhaps transporting the cocoa). The road East of Awurabo (towards 'Japan Bridge') had been re-graded in June 2000 (Kathrin Blaufuss / Frank Owusu Acheampong, pers comm.). The distances from Awurabo village East to the market at Assin Akonfonde (via 'Japan Bridge') or South to the market at Assin Akropon are both in excess of 10 km, the latter feeder road being particularly gullied (Figure 24).

Figure 24. A heavily gullied section of feeder road near to Awurabo village

3.5.3. Paths

Path 1 leads from Awurabo in the Southwesterly direction towards 'Japan Bridge'. The first section of this path is gullied, and rocks have been used to attempt to check the development (Figure 25). Further along the path, there is evidence that a tracked-vehicle had been used to widen the path (undertaken during July-August 2000; Kathrin Blaufuss / Frank Owusu Acheampong, pers comm.). The undulating surface of this track indicates some local instability / erosion (Figure 24). Awurabo is within an area mapped as Acrisol (locally 'Nsaba-Swedru / Nta-Ofin Association'; Asamoa, 1968). The presence of cracking may indicate the presence of unstable clays (Figure 26) and hence the possibility that these soils may be a more erodible Acrisol-Alisol intergrade (Driessen and Dudal, 1991). The Alisol classification has only been identified since 1988; such soils were formerly classified with the more stable members of the old Acrisol group. Local cation exchange capacity (CEC), clay percentage and base saturation would be required to support such a hypothesis.

Figure 25. Gully at the start of path 1, Awurabo village. Some gully control may have been undertaken with rock placement.

Path 2 leads in a South by Southwest direction towards a relatively large bridge constructed by the community (Figure 27). Path 3 starts from the same point on the Southern edge of Awurabo village as Path 2, but continues in Southerly direction towards (and beyond) a small bridge. Water is abstracted from these two bridge locations for most of the year. The terrain is relatively flat along course of Path 2 and 3, so there are little signs of erosion.

3.5.4. Summary of key issues

Development of the gully at the start of Path 1 may make IMT use difficult, as may further deterioration of a latter section of the same path that was affected by a tracked vehicle. Path 1 may be sensitive to IMT damage during wet seasons and should be monitored. The streams and narrow bridges along Path 2 and 3 may inhibit the use of IMTs for transporting produce from distant fields.

3.5.5. Monitoring recommended

Observe the development of the gully at the start of Path 1, and record any repairs (soil conservation measures). Observe if the tracked-vehicle damage to Path 1 further deteriorates or stabilises.

Figure 26. A section of Path 1 (Awurabo village) widened by a tracked vehicle, showing signs of swelling clays (i.e., instability) and gullying

Figure 27. The cedar bridge constructed by the community along Path 2, Awurabo village

4. Common issues

All five villages are likely to have relatively low rates of erosion and mass movement (i.e., < 200-400 t km^{-2} yr^{-1}) when compared with volcanic, loessial, and/or mountainous regions of the humid tropics (Walling and Webb, 1983). Despite this, very localised areas of gully development, soft ground or high local relief along paths may impair the use of IMTs at all villages under investigation. At three of the five villages (i.e., Abora, Sampa and Awurabo), surface runoff generated in the village compound generates severe gullying on some footpaths radiating out from village. Directing surface runoff away from path entrances would significantly reduce trafficability problems. Grated, cut-off trenches, as used in near-urban villages in Malaysia/Singapore may be a useful runoff-management technology that could be applied.

All feeder roads studied had been repaired within the last 1-3 years, and so are of a good standard for such lateritic roads.

5. References

Adiku, S.G.K., and Stone, R.C. 1995. Using the Southern Oscillation Index for improving rainfall prediction and agricultural water management in Ghana. *Agricultural Water Management*, 29, 85-100.

Adiku, S.G.K., Dayananda, P.W.A., Rose, C.W, and Dowuona, G.N.N. 1997. An analysis of the within-season rainfall characteristics and simulation of the daily rainfall in two savanna zones in Ghana. *Agricultural and Forest Meteorology*, 86, 51-62.

Adu, S.V., and Asiamah, R.D., 1992. *Soils of the Ayensu-Densu Basin, Central, Eastern and Greater Accra Regions, Ghana*. Memoir 4. Soil Research Institute, Kumasi.

Asamoa, G.K. 1968. *Soils of Ochi-Nakwa Basin*. Memoir 4. Soil Research Institute, Kumasi.

Chappell, N.A., McKenna, P., Bidin, K., Douglas, I., and Walsh, R.P.D. 1999. Parsimonious modelling of water and suspended-sediment flux from nested-catchments affected by selective tropical forestry. *Phil. Trans. Roy. Soc. Lond. B,,* 354, 1831-1846.

Deckers, J.A., Nachtergaele, F.O., Spaargaren, O.C., 1998. *World reference base for soil resources: Introduction*. Acco, Leuven, pp165.

Douglas, I. 1977. *Humid landforms*. MIT Press, Cambridge, pp288.

Douglas, I., Bidin, K., Balamurugam, G., Chappell, N.A., Walsh, R.P.D., Greer, T., and Sinun, W. 1999. The role of extreme events in the impacts of selective tropical forestry on erosion during harvesting and recovery phases at Danum Valley, Sabah. *Phil. Trans. Roy. Soc. Lond. B,,* 354, 1749-1761.

Driessen, P.M., and Dudal., R. 1991. *The major soils of the world*. Agricultural University, Wageningen, pp309.

Frempong, E.M., and Tsidzi, K.E.N, 1999. Blending of marginally suitable tropical sub-base materials for use in base course construction. *Construction and Building Materials*, 13, 129-141.

Opokuankomah, Y., and Cordery, I. 1994. Atlantic sea-surface temperatures and rainfall variability in Ghana. *Journal of Climate*, 7, 551-558.

Porter, G. 1999. *Access to market opportunities in Ghana's off-road communities*. Final Technical Report, DFID project R7149, University of Durham, UK.

Porter, G. 2000. *Action research to evaluat the impact on livelihoods of a set of post-harvest interventions in Ghana's off-road settlements: focus on IMTs.* Project Memorandun Form Info. Department for International Development, UK.

Siaw, T.A. 2000. *Report on the possible use of IMTs on some selected farm tracks in the Gomoa and Assin districts of Ghana*. VIP Cape Coast, Ghana

Walling, D.E., and Webb, B.W. 1983. Erosion and sediment yield. In *Background to palaeohydrology*, ed., K.J. Gregory, 69-100. Wiley, Chichester, UK.

Document Number: CRES/QA/EROSION/1/0401/1.1

Title: Evidence of soil instability and erosion along paths and roads in five villages of Central Ghana

---

Distribution List

NAME AND AFFILIATION	
Dr Gina Porter (University of Durham, UK) for further circulation	
CHECKED BY:	(Senior Officer)
DATE:	