CHAPTER 3: MATERIAL AND METHODS

3.1.2 General literature, maps and other data.

3.1.2.1 Kromme River:

i) General description of the wetland site.

The Kromme River wetland is situated in the upper catchment of the Kromme River (Eastern Cape). The 48 km peatland complex is a long linear feature within a steep narrow Cape fold valley, on privately owned land (Figure 4). The Kromme River wetland is one of the largest peatlands in the Eastern Cape (Haigh *et al.*, 2002).

Figure 4: The Kromme River wetland.

Parallel ridges of the Cape Fold mountain range to the north and south define the Kromme River valley. Numerous tributaries drain into the Kromme River from these steep slopes (25% - 40%). The river flows in an East-Southeast direction. Incised alluvial fans have developed at a number of places where tributaries entered the main axis between Kromdraai, Kompanijsdrif and at Hendrikskraal, Jagersbos and Hudsonvale (Figure 5) (Haigh *et al.*, 2002).

Figure 5: Topographical map section of the Kromme valley with 1954 aerial photograph showing an alluvial fan at Hudsonvale.

The dominant plant species found in this wetland is *Prionium serratum* (Figure 6). Some areas contain wet grassland and sedges.

Figure 6: Palmiet (*Prionium serratum*).

The average long-term rainfall data (Figure a in Appendix 2) (ARC-ISCW, 2002) indicates that the maximum rainfall occurs in August, October and November although rain does fall throughout the year. The region of the Kromme River wetland receives approximately 700 mm of rain annually (ARC-ISCW, 2002). According to Haigh *et al.* (2002) the principal rainy season seems to be during the winter months.

The climatic regime for the area is characterized by high-energy flood events and frequent fires. The combination of shallow sandy soils and steep slopes with this climatic regime predisposes this valley for rapid deterioration through erosion, once the natural land cover has been disrupted (Haigh *et al.*, 2002).

A summary of landscape changes in the Hudsonvale peat basin is described from aerial photographs of 1942 (earliest obtainable), 1954 (before the new road was constructed), 1961, 1969 and 1986 (Appendix 5) (Haigh *et al.*, 2002).

- Incisement (erosion) of banks, channels and headcuts.
- Headcut stabilization and migration.
- Siltation of channels, sandbanks.
- Hydrological regime – smaller channels networking the sandbank.
- Revegetation.
- Land cultivation.
- Alien vegetation encroachment.
- Density of vegetation.
- Vegetation species.
- Over-grazing.
- Bare soil.
- Visibility of water.
- Size of the fluvial plume.
- Migration of the confluence point of two rivers.
- Infrastructure.

ii) Rehabilitation information (Gamtoos Irrigation Board, 2002).

The problems in the Kromme River wetland are mainly due to the land use practices, namely:

- Agricultural activities (clearing, over-grazing and draining of the wetland).
- Roads, causeways and storm drains resulting in erosion.
- Alien vegetation infestation.
- Fires.
- Sand mining.

These land use practices resulted in the destruction of the wetland and caused the loss of valuable wetland functions. The erosion of alluvial soils (sandy and not dispersive) derived from Table Mountain sandstone caused massive downstream sedimentation. Increasing flood events and siltation cause severe damage to the Churchill and Impofu dams (Gamtoos Irrigation Board, 2002).

In 1998, at least eight major headcuts in the Kromme River were identified, and since then, seven have been repaired with gabion structures. Other problems like channel bank erosion expose the bedrock (Figure 7) (Haigh *et al.*, 2002).

Figure 7: Extensive channel bank erosion exposing bedrock. Horizons of dark organic, sometimes peat-like material, alternating with lighter coloured sands (relatively poor in organic material) reveal the episodic nature of the sediment supply from the tributary catchments.

iii) Rehabilitation objectives (Gamtoos Irrigation Board, 2002).

1. Flood attenuation and base flow support to the storage dams.
2. Stop further sedimentation of the storage dams.
3. Stop further degradation and erosion of the wetlands.
4. Water purification.
5. Conservation of rare habitat and enhancement of natural biodiversity.
6. Poverty relief and skills development.

iv) Offsite actions required (Gamtoos Irrigation Board, 2002).

1. Removal of alien vegetation infestation (*Acacia mearnsii*) in the riparian zone.
2. Stakeholder involvement.
3. Training and education, safety awareness and productivity control.
4. Ongoing environmental monitoring.
5. Improve catchment management (control of fires, clearing, erosion on slopes and paths, and over-grazing).

v) Monitoring & Maintenance (Gamtoos Irrigation Board, 2002).

1. Follow–up monitoring and maintenance visits by the Design Engineer and Implementing Agent to monitor the stability of the structures.
2. Rehabilitation monitoring by Senior Project Manager with assistance from a Technical Advisor.
3. Monitor the revegetation and riverbank stability through long-term fixed point photography.
4. Control of invasive plant species.
5. Fencing-off the structure to exclude animals (Figure 8).
6. Monitor the headward movement of the headcut at Kompanjesdrif.

Figure 8: The area around the structure must be fenced off to prevent over-grazing and trampling by cattle.

The photos of each rehabilitation structure were taken during the preliminary field visit (9 July 2002). Figure 9 describes the wetland rehabilitation site layout details and Table 6 gives a summary of the problems, rehabilitation actions taken and the desired results to attain after the rehabilitation.

vi) Wetland Rehabilitation site details.

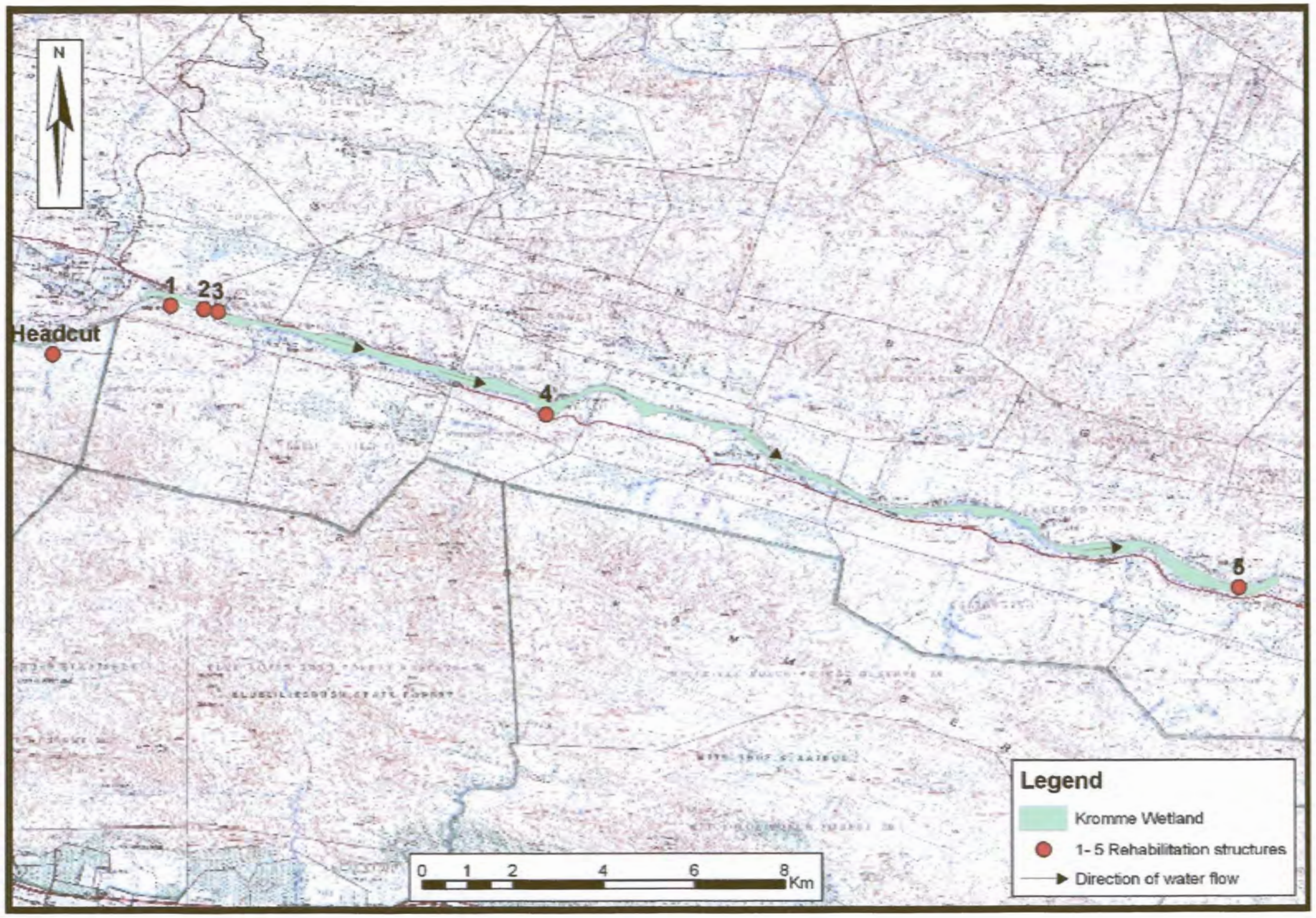


Figure 9: Topographical maps (3324 CD, 3324CC, 3323 DD) showing the locations of the rehabilitation structures 1- 5 as well as the headcut of the Kromme Wetland in the Eastern Cape.

Table 6: Kromme River Wetland: Summary of the problems, rehabilitation actions taken in 2001/2002 and the desired results to be attained after the rehabilitation.

Site no.	Problems	Rehabilitation action	Desired results
23°58' 22" 33°52' 21"	Headcut erosion at a side tributary in the upper catchment area (Figure 9 & 10). The fynbos vegetation differs from the palmiet (*Prionium serratum*) that dominates the main wetland in the Kromme River.	Gabion and concrete structure.	• Structures must act as silt traps. • Rehabilitation of indigenous vegetation. must protect the soil.
1 23°59' 45" 33°51' 46"	Eroded river channel in river bed of 8.5 m wide and 3.5 m deep.	3.5 high concrete gravity structure (Figure 11) 4 m wide at bottom and 8.5 m overflow width build on rock foundation.	• Structures must act as silt traps. • Rehabilitation of indigenous vegetation must protect the soil. • Lift water table. • Dissipate the energy of floods. • To prevent further erosion of the wetland.
2 24°00' 19" 33°51' 48"	Headcut 2.5 m deep and 9.5 m wide eroded river channel within riverbed.	2.5 m high concrete gravity structure (Figure 12) 3m wide at bottom and 9.5 m overflow width build on rock foundation across a narrow section of the river below a headcut.	• Structures must act as silt traps. • Rehabilitation of indigenous vegetation. must protect the soil. • Lift water table. • Dissipate the energy of floods. • To prevent further erosion of the wetland.
3 24°00' 08" 33°51' 51"	Headcut 5.5 m deep and 17.5 m wide eroded channel within riverbed.	5.5 m high concrete gravity structure (Figure 13) 6 m wide at bottom and 17.5 m overflow width build on rock foundation.	• Structures must act as silt traps. • Rehabilitation of indigenous vegetation. must protect the soil. • Lift water table. • Dissipate the energy of floods. • To prevent further erosion of the wetland.
4 24°04' 12" 33°52' 59"	Headcut 3.0 m deep and 11.0 m wide eroded river channel within riverbed.	Gabion weir (Figure 14). The area needs to be sloped to enable the revegetation of the riverbanks with indigenous vegetation.	• To prevent further erosion of the wetland. • Prevent down stream sedimentation. • Stabilise river banks.
5 24°12' 29" 33°55' 09"	Headcut 3.0 m deep and 21.0 m wide eroded river channel within riverbed.	Gabion weir on soil foundation (Figure 15). 3.0 m high gravity structure, 4 m wide at bottom and 21.0 m overflow width.	• To prevent further erosion of the wetland. • Regain part of the wetland that has eroded away. • Decrease siltation • No alien plant infestation

Figure 10: Landscape around the headcut at a tributary of the Kromme River. This rehabilitation was done in a first order stream and not in a wetland.

Figure 11: Close-up photo of the headcut rehabilitation structure at a tributary of the Kromme River. This rehabilitation structure will not form part of the Wilge River Wetland study but indicates rehabilitation measures in the catchment.

Figure 12: Rehabilitation structure 1: Concrete Weir being constructed.

Figure 13: Rehabilitation structure 2: Concrete Weir being constructed.

Figure 14: Rehabilitation structure 3: Concrete Weir being constructed.

Figure 15: Rehabilitation structure 4: Gabion weir at Kompanjiesdrif.

Figure 16: Rehabilitation structure 5: Gabion weir at Hudsonvale. Note the revegetation on the sides.

3.1.2.2 Mbongolwane Wetland:

i) General description of the wetland site.

The Mbongolwane wetland in KwaZulu-Natal is situated 40 km west of Eshowe. This wetland plays an important role in terms of its hydrological importance to the Amatikulu catchment as well as its cultural and natural resource value to the Ntuli Tribe.

Land use in the wetland area incorporates the utilization of the wetland as an important resource in terms of:

- Water use.
- Grazing.
- Cultivating crops.
- Forestation.
- Medicinal plants.
- Plant material for craft making and thatching.

A diversity of different dominant vegetation types can be found on the hydrological zones in the wetland, namely: reed marsh (*Phragmites australis* [Cav.] Steud.), bulrush marsh in permanently waterlogged areas; sedge marsh (*Cyperus latifolius)* in permanently to seasonally waterlogged areas; and wet grassland in temporarily waterlogged areas (Figure 17) (Kotze, 1999).

Mbongolwane wetland is situated in a summer rainfall region. The maximum rainfall months are December, January and February (Figure b in Appendix 2) (ARC-ISCW, 2002). Mbongolwane receives approximately 900 mm of rain annually.

Figure 17: Part of the Mbongolwane wetland with cattle grazing on the wet grassland and harvested sugar cane in the foreground.

About 10% of the wetland is currently used for subsistence agriculture practices (Kotze, 1999). No heavy machinery, pesticides and artificial fertilizers are used and the cultivated areas are frequently rotated to allow the natural vegetation to re-grow.

A root crop (*Colocasia esculenta*), referred to by the Zulu people as "madumbes" (Figure 18), is the most commonly grown crop at Mbongolwane wetland and is grown mainly in *Cyperus latifolius* marsh (Kotze, 1999).

Traditional methods used to cultivate madumbes are less harmful to the wetland than large-scale, mechanized cultivation. However, cultivating the sensitive areas in the wetland (areas with high erosion potential, support important habitats or species or are important drinking water supply areas) can influence the functional value of the wetland (Kotze, 1999).

Madumbes, maize and pumpkins are grown mainly in *Cyerus latifolius* marsh (seasonally wet zone). Mixed vegetable patches (including maize, potatoes, tomatoes, cabbages, pumpkins and legumes) are found predominantly in the wet grassland areas (temporarily wet zones) (Kotze, 1999).

The easily digestible starchy rhizomes and the young leaves (used as "marog" / spinach) of the madumbe plant provide a dietary supplement to maize (Kotze, 1999).

Figure 18: A root crop (*Colocasia esculenta*) referred to by the Zulu people as madumbes.

Harvesting of plant material from the wetland takes place during the months December to June for "ikhwane" (*Cyperus latifolius)* and the end of April for reeds (*Phragmites australis*).

Ikhwane (*Cyperus latifolius)* is an important resource for making traditional wedding gifts (Figure 19), and the reeds (*Phragmites australis*) are used for thatching houses (Kotze, 2000).

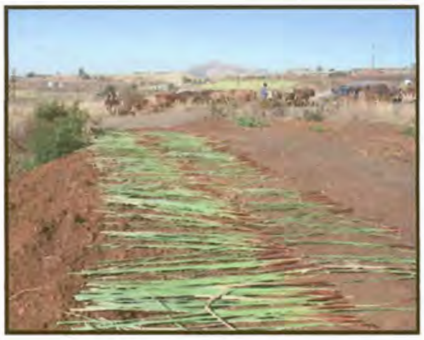


Figure 19: Harvesting Ikhwane for making sleeping mats and bags.

ii) Rehabilitation information.

The wetland is situated in the upper Amatikulu catchment. Two large headcuts were identified: one in the wetland at a site called Amatigulu, the second is on a stream that enters the wetland called Uvova.

Aerial photographs of the two sites, Amatigulu (Figure 20) and Uvova (Figure 21) clearly show landscape changes from 1937 to 1991.

Summary of landscape changes deduced from aerial photographs:

- Erosion channels and headcuts.
- Hydrological regime.
- Land cultivation.
- Density of vegetation.
- Bare soil.
- Visibility of water.
- Infrastructure.

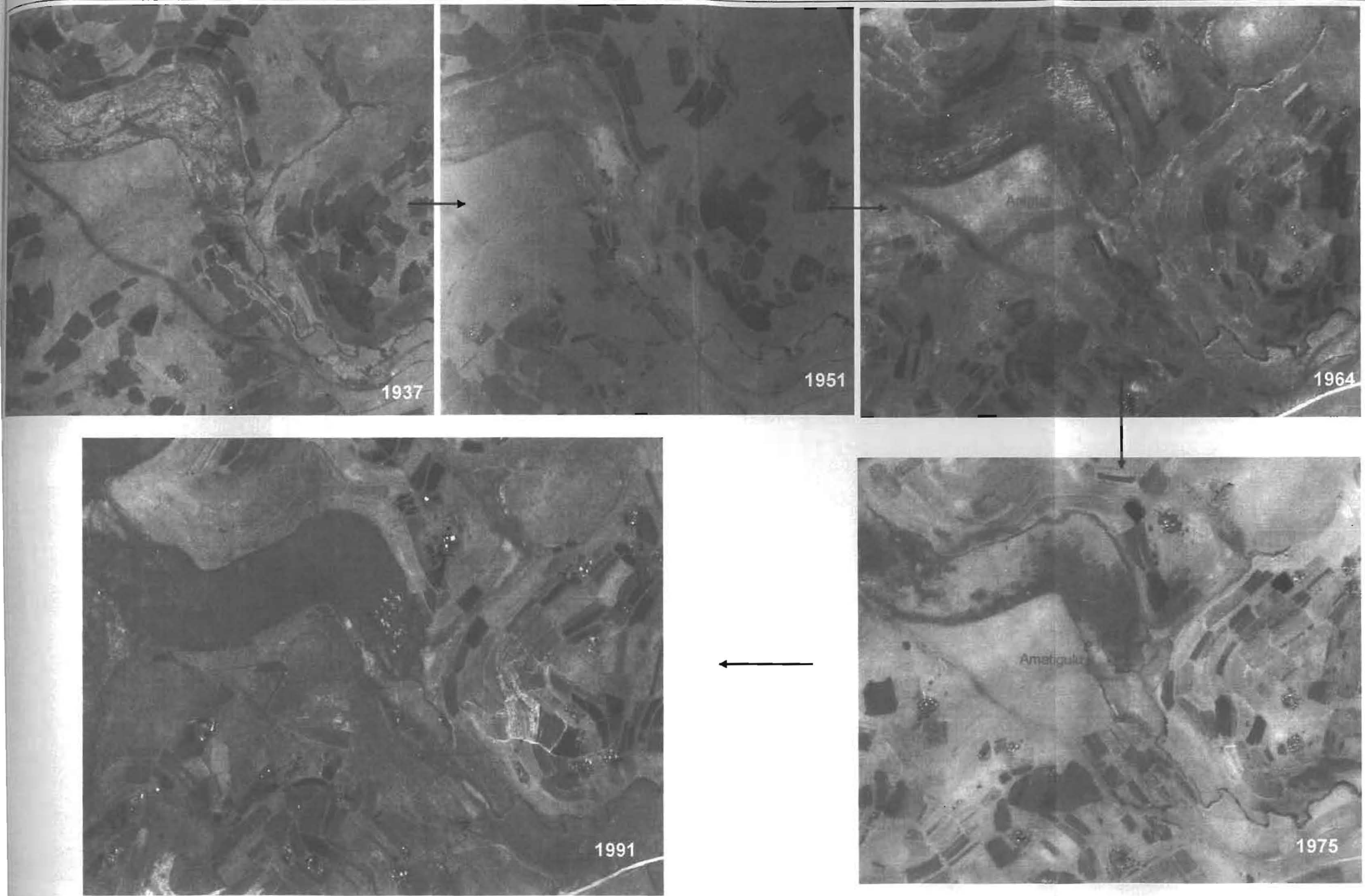


Figure 20 : Site 1 : Amatigulu. Aerial photographs depicting landscape changes.

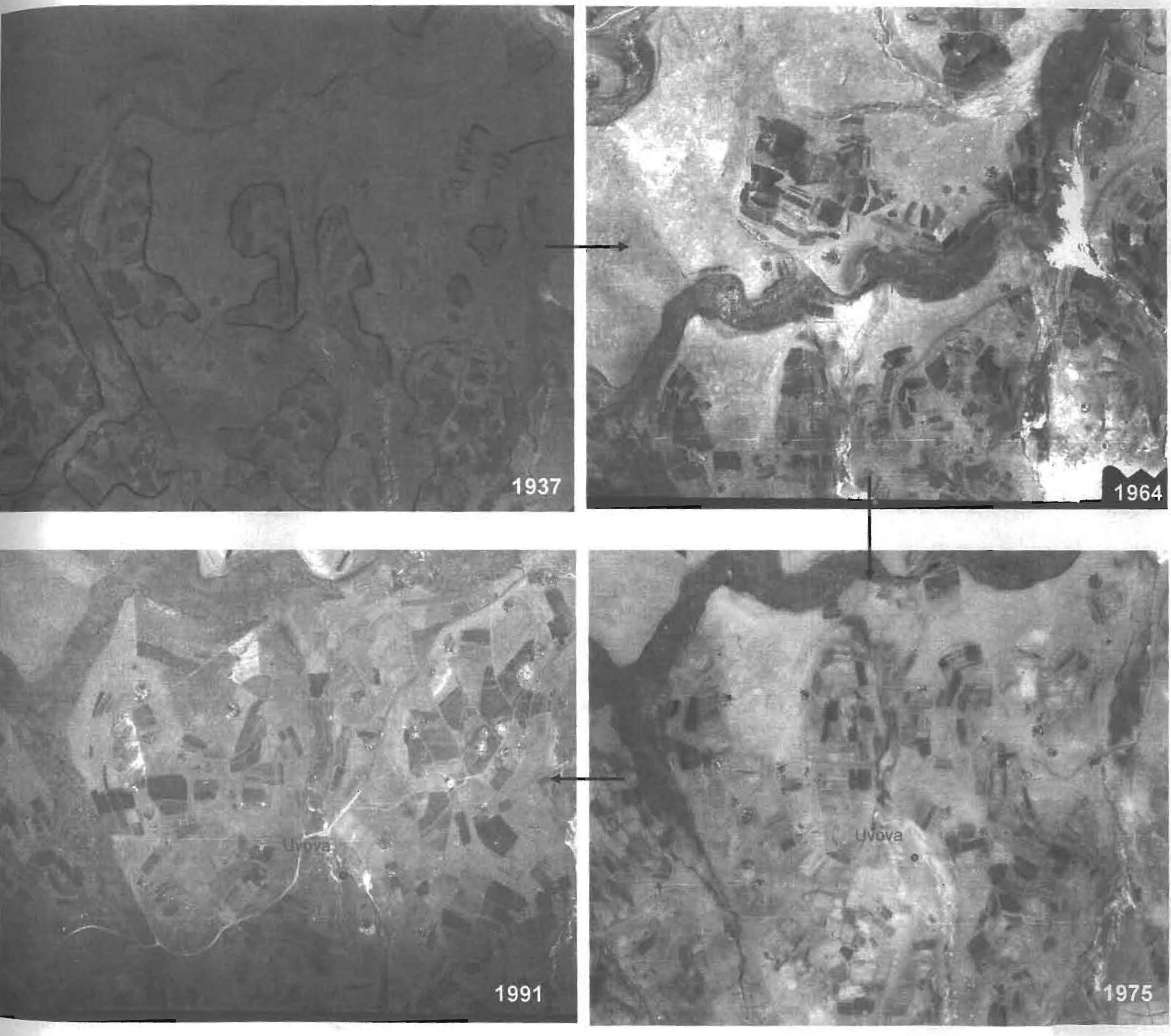


Figure 21 : Site 2 : Uvova. Aerial photographs depicting landscape changes.

Land use practices (Figure 22) like the cultivation of sugar cane, using natural veld for grazing, cropland and homesteads, increase the sediment deposits and nutrient backflow into the river system. These wetland threats place increasing pressure on the wetland's water purification capability. This situation also increases the susceptibility to diseases like cholera and bilharzias and needs to be monitored.

Figure 22: Some of the activities which impact on Mbongolwane Wetland: Sugar cane, forestation, cash crops, washing clothes.

iii) Rehabilitation objectives.

1. Flood retention and base flow support.
2. Stop further degradation and erosion of the wetland.
3. Poverty relief and skills development.

iv) Offsite actions required.

1. Stakeholder involvement.
2. Training and education, safety awareness and productivity control.
3. Catchment land use planning.

v) Monitoring & Maintenance.

1. Monitoring the rehabilitation structure by the Senior Project Manager with assistance of a Technical Advisor.
2. Diseases like cholera and bilharzia need to be monitored.
3. Monitor flood retention and base flow support.
4. Monitor the headward movement of the headcut.
5. Poverty relief and skills development.
6. Monitor the overall hydrological state of the upstream area of Amatigulu and Uvova.
7. Monitor the deposition of sediment downstream of the structure.

vi) Wetland Rehabilitation site details.

The Mbongolwane wetland in KwaZulu-Natal meanders for 12 km. There are two sites at Mbongolwane that had work scheduled for 2002/3. Two large chutes were planned, one in the wetland at Amatigulu, the second is on a stream which enters the wetland at Uvova. The concern at the Amatigulu site is the area of wetland under threat from the continued and extensive movement of the headcut and the associated gully. This wetland area is largely permanently saturated and characterized by diffuse flow. The hydrological consequences of further erosion are therefore potentially very significant. It would therefore be important to monitor the overall hydrological state of this upstream area.

Figure 23 describes the wetland rehabilitation site layout details and Table 7 gives a summary of the problems, rehabilitation actions taken and the desired results to attain after the rehabilitation.

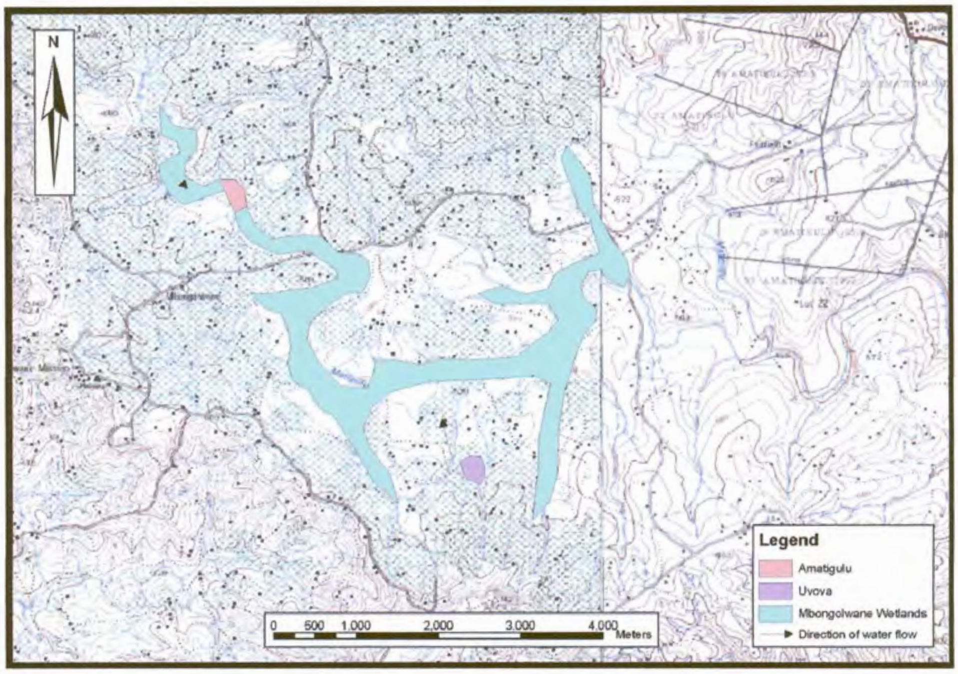


Figure 23: Topographical maps (2831CC & 2831 CD) showing the locations of the two rehabilitation structures (Uvova and Amatigulu).

Table 7: Mbongolwane Wetland: Summary of the problems, rehabilitation actions taken in 2002 and the desired results to be attained after the rehabilitation.

Site no.	Problems	Rehabilitation action	Desired results
1 Amatigulu S 28°55.00" E 31°12'33"	Head cut of 3 m, which was eroding upstream and eroding further and further into the wetland with each summer rainfall period (Figures 24, 25, 26, 27 and 28).	A large concrete filled geocell chute with baffles	• Dissipate the energy of floods. • Prevent further erosion of the wetland.
2 Uvova S 28°56'45" E 31°14'07"	An active headcut situated in the Uvova stream. The stream enters the Mbongolwane wetland (Figures 29 and 30).	A concrete filled geocell chute with baffles	• Dissipate the energy of floods. • To prevent further erosion of the wetland. • Reduce the extent of Sediment generated and deposited in the main body of the wetland.

Preparatory work of shaping both the chutes at a 1:5 slope was planned for the dry winter period (started at June 2002 and carried into July). The first field visit at each of these sites took place on 4 July 2002.

After 6 weeks of structure work at each site, 600 mm of rain fell in the catchment between 16 – 22 July 2002. This heavy downpour event was totally out of season. The Mbongolwane wetland falls in a summer rainfall region, the maximum rainfall months are: December, January and February (Figure b in Appendix 2) (ARC-ISCW, 2002).

Astrup (2002) commented that all the preparatory work at both the sites was totally destroyed (Figure 24). Flood waters gushed through the sites and caused serious erosion on the chute preparation (Figure 25, 26, 27, 28, 29 and 30). Astrup (2002) explained further that it was impossible to start again with chute preparation due to water flow and the loss of precious work time. The risk of spring rains would threaten chute preparation work started at this stage. Large volumes of water flowed through the Amatigulu site right up until August. A decision was taken to re-plan a structure for the winter of 2003 (M. Astrup, *pers. comm.*).

Figure 24: Amatigulu site. View of the damaged geocell chute after July 2002 floods. Note the lush green grass after the rains.

Figure 25: Before flooding. Photo taken downstream on 4 July 2002 at the Amatigulu site.

Figure 26: After flooding. Photo taken downstream after July 2002 at the Amatigulu site. Geocell chute preparation at 1:5 gradient (Photo: M. Astrup).

Figure 27: Before flooding. Photo taken up stream on 4 July 2002 at the Amatigulu site.

Figure 28: After flooding. Photo taken upstream after July 2002 at the Amatigulu site. Geocell chute preparation at 1:5 gradient (Photo: M. Astrup).

Figure 29: Before flooding. Photo taken on 4 July 2002 at the Uvova site.

Figure 30: Uvova site damage to chute preparation after July 2002 floods (Photo: M. Astrup).

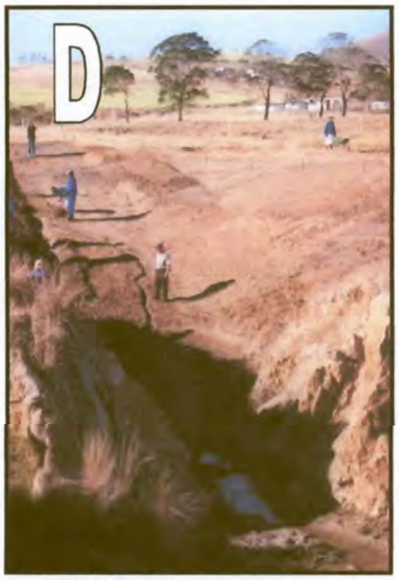
At the Uvova site a re-assessment was done, together with Mr. Bill Russel (WfWet consultant), for the construction of:

A 25 - m long sand bag groyne (Figure 31 a) to divert the stream flow away from the headcut site of the donga, together with an earthen embankment with a small buttress weir 300 mm high and 45 m long (Figure 31 b) across the stream so as to evenly spread water flow. In addition, a 500 mm high earthen embankment (storm drain) (Figure 31 c) was constructed directly above the headcut site so as to ensure water does not enter at this point. Reparation work on the Uvova site was done during September and October 2002 (Figure 31 d).

Sandbag groyne to divert stream to right-hand course away from headcut. This is a temporary structure while stream formalizes channel to the right.

Buttress weir under construction. 50mm PVC piping will carry base flow into headcut site.

Earthen embankment (500 mm) high storm drain to keep floodwater away from headcut on left. Large earthen *embankment and buttress weir visible on* top left of photo.



Preparation for geocell chute work.

Figure 31: Reparation work on the Uvova site was done during September and October 2002 (Photo: M. Astrup).

A concrete chute is planned for where the stream flow enters the drainage line (Figure 32). The position will be about 400 m below the headcut.

Figure 32: An eroding headcut situated on the Uvova stream. The stream enters the Mbongolwane wetland. Photo taken on 4 July 2002.

3.1.2.3 Wilge River Wetland:

i) General description of the wetland site.

The Wilge River wetland is also known as Bedfordview or Watervalvlei wetland. The Wilge River wetland is situated in the upper catchment of the Wilge River in the north-eastern Free State near Harrismith and stretches over three privately owned farms.

These are:

- Bedford (21845). Owner: Mr. Piet Blom. This portion of wetland contains peat.
- Chatsworth (388). Owner: Mr. George Gallaway.
- Wilge River (319). Owner: Mr. Willem de Jager.

An aerial survey of the Wilge catchment by Rand Water revealed a headcut at the outlet of a wetland on the farm Wilge River 319 (hereafter referred to as the Wilge River wetland). The wetland rehabilitation has been performed on this portion of wetland in the upper catchment of the Wilge River (N. Collins, *pers. comm.*) (Figure 33).

Figure 33: The Wilge River Wetland and rehabilitation structure at the headcut.

The Wilge River wetland is of international conservation value. It is not only stated to be the best conserved high altitude palustrine type wetland within the whole of South Africa but also serves as an important habitat for globally endangered species like the Whitewinged Flufftail (Taylor, 1997). This is one of only ten known sites in the country where this bird is found (Figure 34). Furthermore this wetland contains one of the oldest known peat deposits on the Highveld (10 500 years old) (P. Grundling, *pers. comm.*; Marneweck *et al.*, 2001).

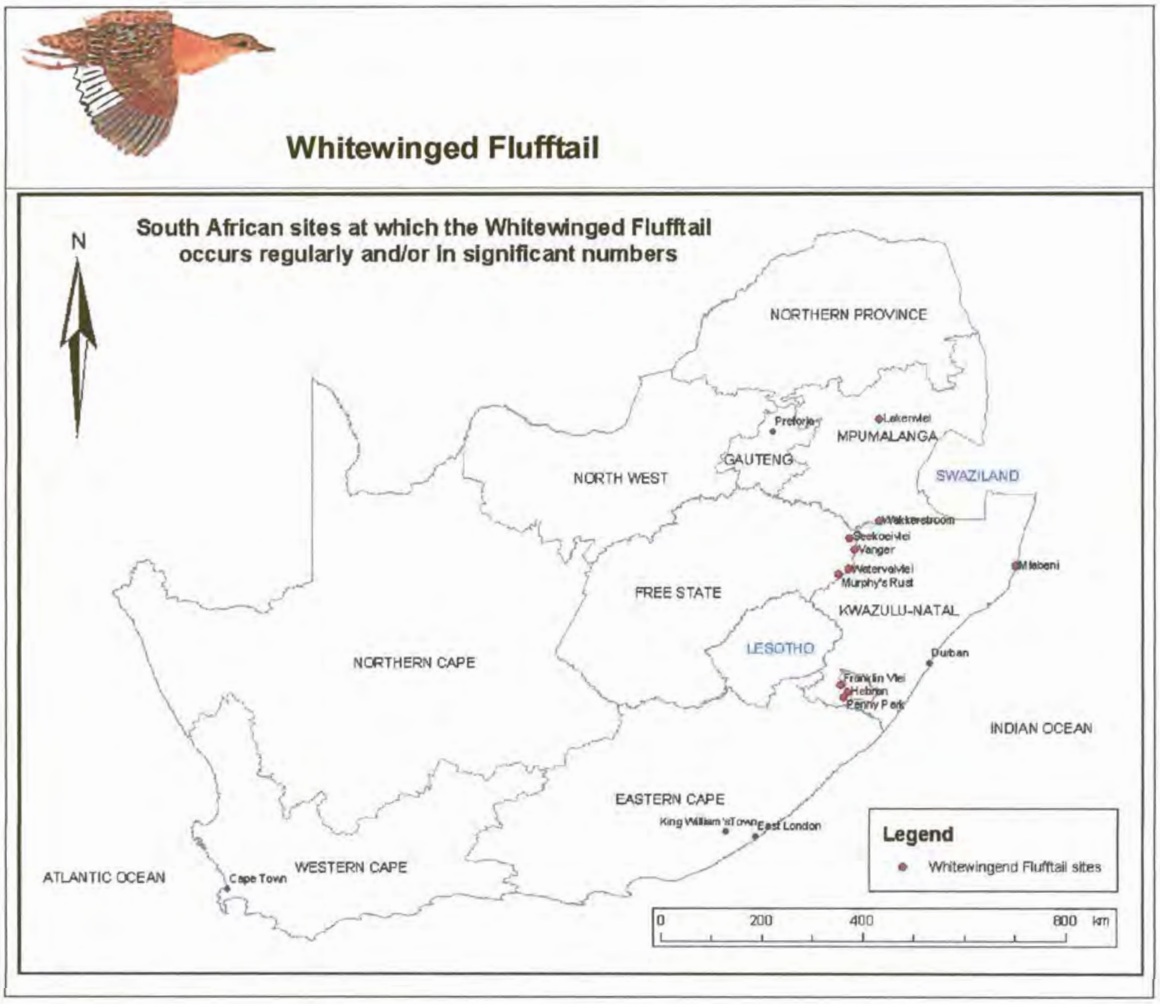


Figure 34: Wilge River Wetland is one of the sites were the Whitewinged Flufftail occurs regularly and/or in significant numbers (Taylor and Grundling, 2003).

Grazing is the main land-use activity within the wetland (Free State Department of Tourism, Environmental and Economic Affairs, 1997). The maximum rainfall occurs during December, January and February (Figure c in Appendix 2) (ARC-ISCW, 2002).

ii) Rehabilitation information

The Wilge River Wetland is one of the last unspoiled wetlands in South Africa. Since 1997 the Free State Department of Tourism, Environmental and Economic Affairs has been actively involved in wetland rehabilitation within this area with funding from Rand Water (N. Collins, *pers comm.*). The wetland is situated in the valley bottom with a flat channel. In its present state the wetland is used for grazing and watering of cattle and game. These are the main land uses and disturbances in the area. The wetland vegetation cover is 100% natural vegetation - not over-grazed (Free State Department of Tourism, Environmental and Economic Affairs, 1997).

According to N. Collins (*pers comm.*), the extensive headcut erosion (Figure 35) was possibly caused by the road crossing lower down the wetland (Figure 36). Erosion causes open water bodies and vegetation degradation. Tunnel erosion is evident in the seepages. These sensitive areas are being trampled by cattle. The wetland is used for watering of cattle; therefore the headcut area must be fenced off to prevent trampling by cattle (N. Collins, *pers comm.)*.