Assessment of the diversity of aquatic macroinvertebrates in the upper Kabouga River to evaluate the impact the construction of an impoundment would have on this fauna

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INTRODUCTION

A proposal to construct a dam along the upper reaches of the Kabouga River before it enters the Gorge through the Zuurberg Mountains requires evaluation regarding the environmental impact such a structure would have on inundating the area upstream of the dam. In order to obtain approval for the proposed construction of the dam, the applicant (Mr. Andre Bezuidenhout) has to submit, via an independent consultant, to the provincial Department of Economic Affairs, Environment and Tourism (DEAET) an Application for Authorisation together with a number of required environmental reports. The impact an impoundment will have on the aquatic macroinvertebrates in the region is one of the aspects that have to be considered. An assessment of the diversity of aquatic macroinvertebrates living in the direct environs of the area to be inundated, as well as in the river and pools downstream of the impoundment are the components that are evaluated in this report.

Definitions

In order to facilitate understanding of some of the terms used in this report some definitions have been included.

Benthic macroinvertebrates: Organisms inhabiting bottom substrates (e.g. stones, sediments, aquatic macrophytes, algae, etc.) for at least part of their life cycle. "Macro" implies that they are visible with the naked eye, though scientifically they are defined as those organisms that are retained by sampling net mesh sizes between 200 to 500 µm (Rosenburg and Resh, 1993).

Biotope: The environment and physical abode of a community or assemblage of species. Two types of biotope can be (A) a riffle (stones-in-current) or (B) a stretch of marginal vegetation in a flowing stretch of a river.

Habitat: The environment and physical abode of a species. Note that each species is usually associated with other species in the same biotope and when referring to the community the term biotope should apply.

Episodic: Periodic or intermittent in flow pattern meaning that it flows for an extended period which is not seasonal or predictable. Flow in the river is usually contributed by rainfall as well as from groundwater. Surface flow may occur only in some reaches and subsurface flow is often the only source of water in the channel.

METHODS

Between 21-23 February 2003 an exploratory survey of the Kabouga River catchment, downstream from the existing impoundment and into the gorge cutting through the Zuurberg Mountains (Fig. 1) was conducted by Mrs H.M. Barber-James and Dr F.C. de Moor of the Albany Museum. Aquatic macroinvertebrates from aquatic biotopes at five sites along the river (Table 1) were sampled and flying adults of aquatic insects were collected with hand nets and by means of light traps set up over two nights (21 and 22 February).

At each sampling site a photographic record was made of the general aquatic environment giving a visual record of the aquatic biotopes and prevailing conditions at the time of sampling (Figs 2 - 22). Aquatic invertebrates were sampled using various water and aerial hand nets ranging in net mesh size from 80 micrometres (0.08 mm) to 1000 micrometres (1 mm). Sampling of aquatic stages was done using a standard SASS net (mesh size 1000 µm) (the standard net used for biomonitoring surveys in the South African River health Program, using the SASS – South African Scoring System – method of biomonitoring); a hand-net (mesh size 250µm); a small D hand-net (mesh size 80 µm) for sampling bedrock in the river. General hand-picking of stones, reeds and sedge vegetation and removable substrates was also carried out. As many aquatic biotopes as possible were sampled at each site and an abbreviated description of biotopes is given in Table 2. Light traps, to collect the adult stages of many aquatic insects important for species identification, were set up at four of the five sites. A light trap using a super-actinic light source over a white tray was used in all instances. General collecting for the flying stages of adult aquatic insects was also carried out.

The biotopes sampled included stones in and out of current, marginal and submerged aquatic vegetation, filamentous and encrusted algae, sediments on substrata, the surface of water bodies. Biotopes were sampled in a number of ways. Invertebrates associated with aquatic plants were collected by means of running a net through aquatic macrophytes and marginal vegetation. Where stony substrata were present, stones were lifted by hand and washed into a collecting net. Aquatic animals were also hand-picked off these stones with a fine pair of forceps. Sediments were stirred up and a coarse-mesh net was run through disturbed sediments and substrates. Where running water was found, stones in the flowing current were dislodged and kicked and invertebrates were carried by the current into a net suspended below the disturbed substrates. A synopsis of all biotopes sampled at each site is given in Table 3.

Unsorted samples as well as selected animals collected were given a catalogue number for each site, date and biotope type. Samples were labeled and preserved in 80% ethanol. Samples were sorted into groups of like species in the laboratory. Identification of animals was carried out using museum-voucher material for comparison, and where specimens of particular species were not available, the library of taxonomic papers held by the Albany Museum was used. Owing to time limitations certain groups of species (certain Hemiptera, Dytiscidae, Chironomidae and various other Diptera families) were not identified beyond family level, but will be sent to specialists for further identification. All material collected will be stored and curated in the Albany Museum, Grahamstown. Material is stored under the Addo catalogue (ADO). The collection contributed 17 separate ADO catalogue entries and 5157 specimens.

RESULTS

Table 4 records the physical water quality parameters recorded and table 5 presents the aquatic macroinvertebrates recorded during the three-day monitoring survey in February 2003. Figures 2-22 record, visually, the conditions of flow and surface water available as well as vegetation prevailing at the time of sampling.

NOTES ON THE MACROINVERTEBRATE FAUNA FOUND

Ephemeroptera (Mayflies)

The mayfly fauna of the Kabouga River recorded on the farm Kaboega during the three-day survey was not diverse. Most of the Baetidae species collected are typical of pools and slow- flowing water. Only at site 5, where there was more rapidly flowing water, did the diversity of species increase. Even here, the species found are well-know, widespread and tolerant of disturbance and water pollution. There was one exception recorded from the light trap at site 5. A single specimen of a species collected could not be determined even to generic level. This is partly because the specimen was damaged, and also because it was not a fully mature adult. Mayflies are unique in the present-day insect world in having two winged stages, the sexually immature subimago, which undergoes a final moult to the mature imago or adult stage. The adult is the stage at which mayflies are identified to species level, where important diagnostic features such as the genitalia are fully-formed and the wing venation is not obscured by microtrichia which cover the wings of the subimaginal stage. It is recommended that a further study be undertaken to collect more of this mayfly, and to correlate the nymphal, subimaginal and adult stages by rearing specimens to see if it is perhaps an undescribed species.

The family Caenidae is poorly known in Africa, with few species formally described. Two species of nymphs were recognized during this study, and an unknown adult species, which may be the adult of one of the species of nymphs collected. It would be valuable to spend time collecting these and rearing them through to associate nymph and adult, which could then be formally described.

Two species of Leptophlebiidae were collected at site 5, the only place where moderately flowing surface water was present. They were also widespread common species.

Odonata (Damsel and Dragonflies)

All the species of Odonata collected were widespread, common species characteristically found along temporary streams or pools in bush, woodland or forest. It is likely that many more species will be collected over time.

The nymphal stages of *Lestes* sp., *Pseudagrion* sp. of an *Anax* sp. (most likely *Anax imperator*) and *Trithemis* sp. were found amongst marginal vegetation along the side of pools. The nymph of a *Paragomphus* sp. was found in floating filamentous algae in a pool in the gorge where an adult of *P. genei* was also collected. These findings indicate that there are a number of species-specific habitat requirements suiting a diversity of Odonata species, all predators as nymphs of other insects to be found in the pools and runs of the Kabouga River.

Hemiptera (Bugs)

Most of the aquatic bugs collected were not identified to species level. The aquatic bugs are a very adaptable group of insects. They are air-breathers at all life stages (nymphs and adult) meaning that they obtain their oxygen directly from the air and have specialized means of preventing their spiracles from becoming wetted under water. The bugs that live under water frequently have to come to the surface to replenish their "stored" air supply. The adult stage of most of these bugs is winged and adult bugs can fly to other bodies of water if their existing source happens to dry up.

The hemipteran families Notonectidae (backswimmers), Pleidae (Pigmy backswimmers), Corixidae (Water boatmen), Belostomatidae (Giant water bugs) and Naucoridae (Creeping water bugs or toe biters) are all underwater aquatic bugs spending most of their time submerged below the water surface. The different species are to be found amongst vegetation, creeping about on the bottom sandy surface of pools or swimming in the middle or below the surface of open water or above the bottom sediment in pools. The families Mesoveliidae (Water treaders), Veliidae (Water striders) and Gerridae (Pond skaters) are found on the surface of pools and runs, usually near vegetation, but the Gerridae venture into open water (Moller-Anderson 1982).

Coleoptera (Beetles)

As with the bugs there are many species of beetles that have specialized for an existence in water. The larval stage of beetles acquires oxygen through cutaneous uptake whereas the adult beetle is an air-breather. The adult stage of the aquatic beetles collected is also winged and could also fly to other bodies of water if their existing source happens to dry up. Beetles were also not all identified to species level. Two species of Gyrinidae beetles were recorded; *Aulonogyrus alternatus* is recorded as being found in temporary aquatic habitats and is widespread and common in the Eastern Cape. *Aulonogyrus varians* is recorded as a SW Cape endemic, with the eastern extent of its distribution reaching Humansdorp. The record of this second species in this survey represents a new distribution (Brink 1955).

Diptera (Two-winged flies)

The mosquitoes (Culicidae) recorded were identified to generic level and the midge families (Chironomidae and Ceratopogonidae) were only identified to subfamily or tribal level. A detailed study of the family Chironomidae would reveal a considerable amount of information about the ecology of the aquatic biotopes but was beyond the scope of the present study. The blackfly family Simuliidae was represented by three species all collected from the running water at site 5. Two species *Simulium ruficorne* and *S. nigritarse* are known to be some of the earliest colonizers of newly inundated rivers and the latter species, comprising a complex of 19 sibling species, can be found in either very small trickles or moderate size rivers (Harrison 1966, Chutter 1972, Palmer and de Moor 1998). *Simulium medusaeforme* is one of the most common and widespread species in southern Africa it is found in a wide range of stream types ranging from temporary streams or mountain streams to foothill streams and medium sized rivers (Palmer and de Moor 1998). All three species of blackfly found were therefore typical of temporary streams.

Trichoptera (Caddisflies)

Thirteen species of caddisfly were collected, all except *Cheumatopsyche* sp. A and a species of *Oecetis* near to *tjonnelandi* are widespread common species. *Orthotrichia barnardi*, a species recorded almost entirely in swift flowing water in the larval stage, was very abundant (several thousand specimens) in light trap samples set in the Kabougas Poort Gorge at sites 4 and 5 and present in small numbers at sites 2 and 3. A second species of hydroptilid caddisfly, *Hydroptila cruciata*, often found in flowing water, but also able to colonise slow flowing and even standing water, was present at all four sites where light traps were set. This species was only present in low numbers and was also collected as larvae at site 3.

The sex ratio of *Orthotrichia barnardi* was highly skewed in favour of females 300:4 and 500:14 at sites 4 and 5. No larvae of this species were collected at any site. Such a large number of individuals of a species showing specialization for living in strong flowing water conditions raises a few questions. Were there swift flowing stretches of water further downstream in the gorge and would these females followed by a few males indicate an upstream recolonisation pattern? Alternatively this species may have a long-lived adult stage and individuals may be waiting for conditions of flow to become suitable for egg laying? A third possibility could be that there was underground flowing water that supported a large population of this species. All three hypotheses are feasible and it would be worthwhile setting up experiments to discover what this anomalous observation really means.

The presence of hydropsychid caddisflies, all running water specialists in the larval stage, at sites 2-5 indicated that running water is present or had been present recently. Larvae were only collected at site 5 where running water over cobbles was present. The numbers of individuals caught were a good measure of the actually observed amount of running water.

Other non-insect invertebrates

The freshwater crab *Potamonautes sidneyi* was observed in a pool and a dead dried crab was collected from a sandy bank in the gorge. This species is common in all river systems in the Eastern Cape. The bulinid snail *Bulinus forskali,* a widely distributed snail, is a typical inhabitant of seasonal rain-filled pools, is capable of undergoing prolonged aestivation during drought conditions and is an intermediate host of the conical fluke *Gastrodiscus aegyptiacus,* a parasite of horses (Appleton 2002).

DISCUSSION

In a survey of the rivers of the Greater Addo National Park (Barber-James *et. al*. 2002, Roux *et. al*. 2002) the Kabouga River was identified as showing insignificant transformation, being entirely included within the planning domain of the Park, displaying a unique river signature and flowing through more than four geomorphological zones. It consequently scored the highest conservation priority for all the rivers within the Greater Addo National Park planning domain. The river was also identified as Episodic (periodic or intermittent) in flow pattern, meaning that it flows for an extended period which is not predictable or seasonal. Flow in the river is usually contributed by rainfall as well as from groundwater. Often surface flow may occur only in some reaches and subsurface flow is then the only source of water in most of the river. The fauna in episodic rivers can differ considerably depending on the flow duration of the river.

Patterns of faunal assemblages found in temporary water ecosystems are established by colonizer or pioneering species on a "first come first served" basis. It is important to take cognizance of this because such a process sets a pattern that can lead to unexpected diversity within a section of river being surveyed. Two adjacent pools in a temporary river system may each have an entirely different assemblage of species. The only cause of this difference will be that the succession of colonizer species from outside differed for each pool resulting in entirely different species compliments. Furthermore this pattern can be very different within the same season in subsequent years, leading to a completely different assemblage of species.

The survey of only three days duration could therefore not be expected to produce a comprehensive list of species. In addition with the limited time and expertise available it was not possible to get all species collected identified. The ecologically important Diptera families Chironomidae and Tipulidae were collected in large numbers but it was not possible to incorporate them in the data analysis. The samples collected have been preserved and could be identified and synthesized at a later date when expertise and time can be found.

The macroinvertebrates collected, with one or two exceptions, do not reveal any species of special interest and most species are widespread and common. Most of the species collected can also be regarded as species possessing strong colonization capacity enabling them to use areas that are newly inundated after long periods of desiccation. Of note was that the diversity of species increased considerably in the gorge (Table 5). This was due to a greater diversity of substrate types and aquatic biotopes resulting from the increased scouring and removal of finer sediment through the greater slope of the river and higher energy of transport of sediments.

The engineers report (Bok and Associates 2003) gives an estimate of the size of the impoundment, with a 12m high dam wall, as 390,000 m^3 with a surface area of approximately 13ha full capacity. The impoundment, if empty before every major flood event, was estimated from simulated flow records from the WR90 database (hydrological data, which are available for all quaternary catchments), to overtop approximately three times in two years, but with the impoundment being partly filled this overtopping frequency would probably be higher (Rowntree pers. comm.). It is thus evident that middle-size floods will be stored behind the dam wall and the flow pattern downstream of the impoundment will be attenuated. Over the life-expectancy of the impoundment, estimated to be 18-20 years (Rowntree pers. comm.), the sediment supply to the downstream channel will be significantly reduced. Geomorphologically the effect of floods will be reduced and sediment delivered to the channel downstream of the dam will consequently also be reduced. Floodwater overtopping the dam spillway will be relatively sediment free and have the potential to scour the riverbed and erode the banks. This will prevail at least until the next tributary deposits sediment into the channel again.

The catchment surrounding the river has been degraded due to long term overgrazing and poor catchment management in the past. This has therefore resulted in higher than natural erosion rates and sediment transport down the river channel. This is notable with long reaches of the river-bed choked with fine sediment (Figs 6, 7, 9, 16 and 19). If a moderate size impoundment is constructed, fine sediment will be retained behind the dam wall. Increased scouring activity downstream of the dam may help return the river channel to a more clearly defined pool-rapid sequence, more characteristic of rivers with less disturbed catchments. With better catchment management now in place, the riparian vegetation cover should also improve, increasing bank stability, and a reduction in sediment supply into the river channel will then follow. The impoundment will provide a number of years of sediment retention, reducing fine sediment load downstream into the river. This will result in a number of years of erosion without sediment replacement and deposition. More perennial vegetation will grow along the banks of the river and this will further help retain sediments at a later stage. The pools in the river channel should become deeper and the rapids and runs more defined. This will increase the heterogeneity of substratum in the river channel providing a greater diversity of aquatic biotopes and lead to a concomitant increase in diversity of aquatic invertebrate species and provide better refuge for indigenous fish species and frogs. Figs 21 and 22 reveal the conditions immediately below an existing reservoir that has acted as a silt and sediment trap for more than 20 years. Here vegetation along the river channel is clearly larger, more lush, and pools are more permanent. Some reed encroachment in the river channel is also notable.

One of the requirements regarding construction of dams, water abstraction or usage of the river channel is that there is, in any river, a natural quantity of water and this has to be determined. Before any development can be approved it has to be demonstrated that sufficient water will remain in the channel downstream of the development. This is to ensure that water flow requirements that support the essential natural ecological processes and biota within the river, as well as water requirements of downstream users of the river are maintained. This is the instream flow requirement (IFR) and the quantity of water is determined as the ecological reserve within the river channel. As there are naturally huge annual and episodic variations in temporary streams, this quantity of water is difficult to determine. As explained above, the biota of temporary streams is opportunistic and their water requirements are sporadic ranging from no water or isolated pools remaining for varying time periods over different years to large unpredictable floods.

Flow alterations caused by the construction of a small dam would therefore not change the natural flow-pattern in any directional fashion (significantly increased or reduced) that would alter the macroinvertebrate species composition in the river so as to be predictably and significantly different from what occurs naturally. Over the longer-time period the river channel with reduced sediment input will alter as described above, leading to greater species diversity.

One of the pitfalls of a moderate sized man-made lake is that there will be a tendency for people to want to introduce alien fish (bass and carp) into this water. These are undesirable species in a natural environment and every effort should be made to ensure that this is not done. A large permanent body of lentic water will also create conditions favourable to certain pest and problem species such as mosquitoes, chironomid midges and certain snails.

OBSERVATIONS AND RECOMMENDATIONS

1. Given the friable nature of the ground and the effects of sedimentation due to overgrazing in this area, it is likely that the proposed dam will result in a reduction of sediment deposition in the downstream reaches. This will improve the heterogeneity of substrate types in the riverbed leading to greater habitat diversity for invertebrate species and hence refuge for a greater variety of species. This may in fact represent a more natural type of river than what exists at present.
2. Under no circumstances should any species of alien fish be introduced into the river system. This will impact the natural dynamics of the system negatively.
3. To get a better understanding of the functioning of the aquatic ecosystem further in-depth studies on certain mayfly and caddisfly species would be desirable.
4. Funding should be made available for setting up a routine monitoring process so that biodiversity changes in the aquatic environment can be recorded.
5. The construction of an impoundment will have minimal negative impact on the diversity of the ubiquitous macroinvertebrate fauna downstream of the dam. The presence of a large body of water holding surface water for a longer period of time annually than the natural unaltered river-course would, will lead to an increase in certain ubiquitous colonizer species of macroinvertebrates that are able to exploit the lentic conditions. Some of these will be pest or problem species and may have to be managed in an environmentally acceptable manner.

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Table 1. Description of sites.

Site	Description	Grid reference	
Site 1	Stream near old house, immediately downstream of proposed dam site	33°15'27"S	25°25'14"E
Site 2	Road bridge immediately upstream of proposed dam site	33°15'14"S	25°25'15"E
Site 3	Below main homestead	33°15'41"S	25°22'42"E
Site 4	1st site in gorge	33°15'42"S	25°22'00"E
Site 5	2nd site in gorge	33°15'50"S	25°22'07"E

Table 2. Key to abbreviations of biotopes sampled for aquatic stages, or sampling of terrestrial stages of aquatic invertebrates.

Biotope	Description
AV	Aquatic vegetation (reeds and sedges in stream)
MVOC	Marginal vegetation out of current (vegetation along edge of steam)
SOC	Stones out of current
SIC	Stones in current
SOP	Surface of pool
FNW	Flying near water
Light	Light trap sample

Table 3. Biotopes sampled at each site.

Site No.	Biotopes sampled
1	AV, MVOC
2	MVOC, SOC, Light
3	SIC, FNW, Light
4	MVIC, MVOC, Light, SOP, FNW
5	SIC, SOP, Light, FNW

Table 4. Water quality parameters measured at each site (not recorded at site 2).

Site	Date and time	pH	Temperature (°C)	Conductivity µS/cm	Total dissolved solids (mg/l)
Site 1	21/II/03 16h58	8.4	25.4	2240	1486
Site 2		-	-	-	-
Site 3	22/II/03 10h40	8.2	27.5	1380	915
Site 4	22/II/03 12h00	8.4	26.4	1440	955
Site 5	23/II/03 11h00	8.0	23.2	1480	986

Table 5. List of aquatic invertebrates collected in the Kabouga River, February 2003
√ = present as aquatic stages * = collected by light trapping or flying near water.

Taxa	Site 1	Site 2	Site 3	Site 4	Site 5
Ephemeroptera					
Baetidae					
Afroptilum sudafricanum					√ *
Baetis harrisoni					√ *
Cloeon africanum					*
Cloeon virgiliae	√	√	√	√	*
Cheleocloeon excisum			√		√
Pseudocloeon glaucum					√
Gen. sp. indet.					*
Caenidae					
Caenis capensis				√	
Caenis sp. 1		√			
Caenis sp. 2		√			√
Caenis sp. subimago				*	*
Leptophlebiidae					
Euthraulus elegans					√
Adenophlebia auriculata					√ *
Odonata					
Lestidae					
Lestes plagiatus					*
Lestes sp. nymphs	√	√		√	
Coenagrionidae					
Pseudagrion kersteni			*		
Pseudagrion sp. nymphs	√	√		√	
Libellulidae					
Crocothemis erythraea			*		
Orthetrum chrysostigma			*		*
Trithemis arteriosa			*		*
Trithemis kirbyi ardens			*		
Trithemis stictica					*
Trithemis sp. nymphs	√			√	
Aeshnidae					
Aeshna miniscula					√
Anax speratus					*
Anax sp. nymphs	√	√		√	
Gomphidae					
Paragomphus genei					*
Paragomphus sp. nymphs				√	

Taxa	Site 1	Site 2	Site 3	Site 4	Site 5
Hemiptera					
Notonectidae					
Enithares sp.	√		√	√	
Anisops sp.	√	√	√	√	
Corixidae					
Micronecta gorogaiqua					*
Belostomatidae	√	√		√	
Naucoridae	√		√		
Mesoveliidae					
Mesovelia sp.	√				
Veliidae					
?*Pseudovelia* sp.	√				
Gerridae					
?*Eurymetra* sp.	√				
Limnogonus sp.				√	
Pleidae					
Plea pullula		√			
Coleoptera					
Gyrinidae					
Dineutus sp.	√				
Aulonogyrus alternatus				√	√
Aulonogyrus ? varians				√	√
Dytiscidae					
Sp. 1	√			*	
Sp. 2	√				
Sp. 3				√	*
larvae				√	
Hydrophilidae					
Berosini					
Berosus sp.	√	√	√	√	*
Diptera					
Culicidae					
Culicinae			√		
Culex sp.				√ *	
?*Culisetia* sp.	√				
Anophelinae					
Anopheles ?turkhandi		*			
Anopheles sp.	√		√	*	
Chironomidae					
Orthocladiinae			√	√	
Chironominae				√	
Tanytarsini			√	√	
Tanypodinae			√	√	
Ceratopogonidae	√				

Taxa	Site 1	Site 2	Site 3	Site 4	Site 5
Simuliidae					
Simulium ruficorne					√
Simulium nigritarse					√
Simulium medusaeforme					√
Trichoptera					
Hydroptilidae					
Hydroptila cruciata		*	√ *	*	*
Orthtrichia barnardi		*	*	*	*
Oxyethira velocipes		*	*		
Leptoceridae					
Setodes squamosus				*	
Oecetis sp. (nr. *tjonnelandi*)					*
Triaenodes sp.		*		*	*
Leptocerina sp.	√				
Leptocerus sp.					*
Hydropsychidae					
Cheumatopsyche sp. A		*	*		√ *
Cheumatopsyche afra				*	√
Cheumatopsyche thomasseti			*	*	*
Macrostemum capense			*		
Ecnomidae					
Ecnomus thomasseti			*	*	*
Decapoda					
Potamonidae					
Potamonautes sidneyi					√
Ostracoda				√	
Copepoda					
Cyclopoida				√	
Collembola					
Poduridae	√				
Hydracarina	√				
Mollusca					
Planorbidae					
Bulinus forskali	√	√	√	√	
Lymnaeidae					
Lymnaea columella	√			√	
Annelidae					
Oligochaeta					
Tubificidae			√	√	
Hirudinea					
Glossophoniidae					
? *Helobdella stagnalis*			√	√	
TOTAL NO. OF TAXA PER SITE	24	17	26	37	36

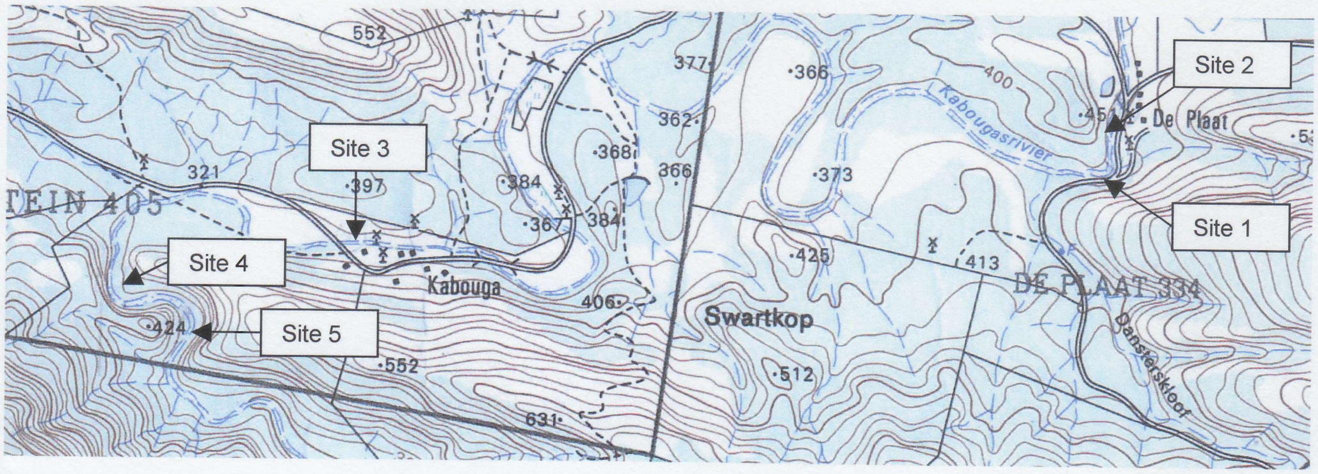

Figure 1. Scale map (from 1:50,000 series) showing sites collected along the Kabouga River .

Figure 2. Downstream view of river c. 200m upstream of proposed dam site.

Figure 3. View from de Plaat farmhouse, showing catchment upstream of proposed dam wall.

Figure 4. Site 1, showing marginal vegetation of reeds.

Figure 5. Site 1, showing grassy bank and sedges.

Figure 6. Site 2, light trap site below causeway, viewing towards proposed dam wall and Zuurberg.

Figure 7. Site 3. Looking upstream towards stone gabian weir.

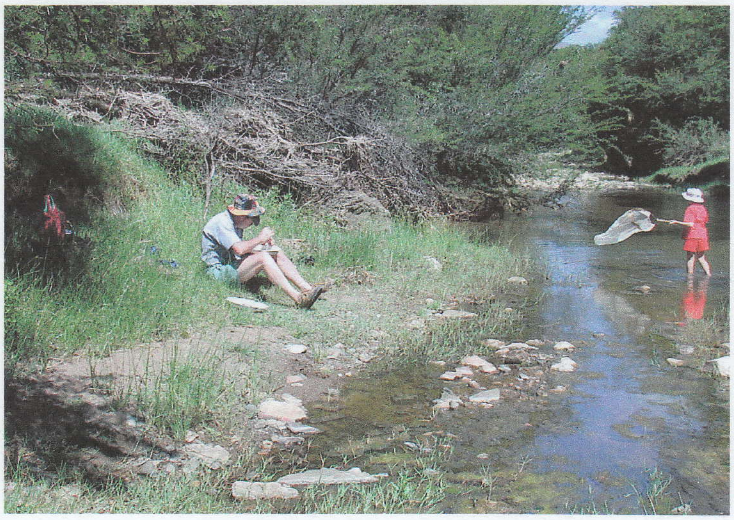

Figure 8. Site 3, downstream of gabian weir showing shallow stream with stones out of current (SOC), marginal vegetation (MVOC) and algal scum.

Figure 9. Site 3. Algal scum growing in thin film of water, showing deposition of fine sediment.

Figure 10. River flowing into Kabouga Poort, where slope increases, resulting in coarser sediments because of higher energy. Pool in foreground .

Figure 11. Site 4. Algal scum, reeds and sedges, and stones and cobbles in slow current.

Figure 12. Site 5. Bedrock-dominated river, with small riffles interspersed with pools.

Figure 13. Closer detail of site 5, showing a section of faster flowing water.

Figure 14. A section of river bank downstream of site 5, showing dislodged trees caused by a previous major flood, mostly large boulders, indicate the high energy potential of this system.

Figure 15. Flat section in gorge, showing grass covered banks of river. Vegetation like this reduces bank erosion and smothering of the channel by silt.

Figure 16. Depositional reach of river, where most of the flow is underground. Adjacent to cliff, scouring action of the river during floods results in water being retained at the surface as pools.

Figure 17. The pattern described in Fig. 17 above is repeated along the course of the river. Note deep channel next to bedrock cliff.

Figure 18. Existing dam wall across Kabouga River, upstream of proposed dam.

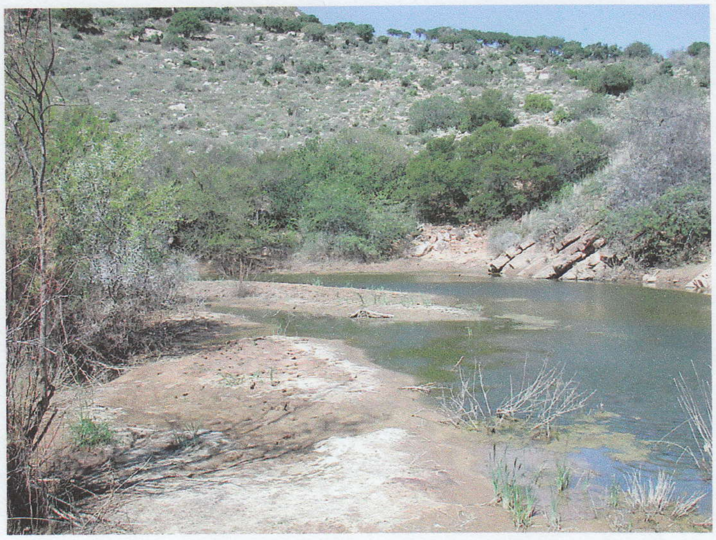

Figure 19. View from dam wall showing sediment laden impoundment.

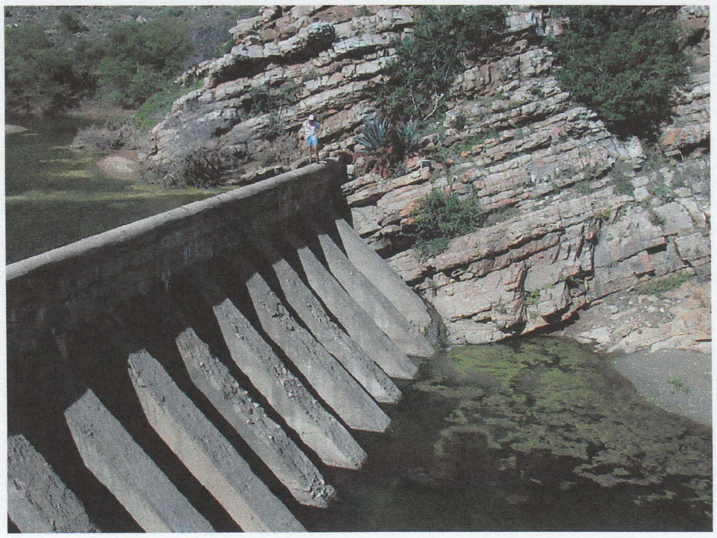

Figure 20. Downstream side of dam wall with water seeping into river from bottom right side of wall.

Figure 21. River channel downstream of dam showing extensive reed growth.

Figure 22. River channel between extant dam and old farm house (site of proposed dam). The extensive growth of riparian tree along the channel is noticeable.

Executive Summary

Effect of proposed impoundment on the biodiversity of aquatic macroinvertebrates in the Kabouga River.

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August 2003

Executive Summary.

Effect of proposed impoundment on the biodiversity of aquatic macroinvertebrates in the Kabouga River.

In a survey of the rivers of the Greater Addo National Park (Barber-James *et. al*. 2002, Roux *et. al*. 2002) the Kabouga River was identified as showing insignificant transformation, being entirely included within the planning domain of the Park, displaying a unique river signature and flowing through more than four geomorphological zones. It consequently scored the highest conservation priority for all the rivers within the Greater Addo National Park planning domain. The river was also identified as Episodic (periodic or intermittent) in flow pattern, meaning that it flows for an extended period which is not predictable or seasonal. Flow in the river is usually contributed by rainfall as well as from groundwater. Often surface flow may occur only in some reaches and subsurface flow is then the only source of water in most of the river. The fauna in episodic rivers can differ considerably depending on the flow duration of the river.

A three-day survey of the aquatic macroinvertebrates associated with the Kabouga River on the Farm Kaboega was carried out in February 2003. The survey was carried out to determine whether the construction of an impoundment on the farm Kaboega would have an impact on the invertebrates found within the proposed dam basin and in the river downstream of the impoundment. Five sites were selected for determining the species diversity of aquatic macroinvertebrates in the river upstream and downstream of the proposed dam site. Sampling of aquatic biotopes and collection of adult insects by means of hand nets and light traps revealed a relatively low diversity of species, and that the dominant species are common and widespread. There were two species that need further study to confirm their status.

Patterns of faunal assemblages found in temporary water ecosystems such as the Kabouga River are established by colonizer or pioneering species on a "first come first served" basis. It is important to take cognizance of this because such a process sets a pattern that can lead to unexpected diversity or paucity of species within a section of river being surveyed. As an example two adjacent pools in a temporary river system may each have an entirely different assemblage of species. The only cause of this difference will be that the succession of colonizer species from outside differed for each pool resulting in entirely different species compliments. Furthermore this pattern can be very different, even within the same season in subsequent years, leading to a completely different assemblage of species.

The conducted survey, of only three days duration, could therefore not be expected to produce a comprehensive list of species. In addition it was not possible to get all species collected identified but samples collected have been preserved and further invertebrates could be identified and synthesized at a later date when expertise and time can be found.

If a moderate size impoundment is constructed, fine sediment will be retained behind the dam wall. Increased scouring activity downstream of the dam may help return the river channel to a more clearly defined pool-rapids sequence, more characteristic of rivers with less disturbed catchments. With better catchment management, now already in place, the riparian vegetation cover should also improve. Better stream-bank stability, and a reduction in sediment supply into the river channel will then follow. The impoundment will provide a number of years of sediment retention, reducing fine sediment load downstream into the river. This will result in a number of years of erosion without sediment replacement and deposition. More perennial vegetation will grow along the banks of the river and this will further help retain sediments at a later stage. The pools in the river channel should become deeper and the rapids and runs become more defined. This will increase the heterogeneity of substratum in the river channel providing a greater diversity of aquatic biotopes and lead to a concomitant increase in diversity of aquatic invertebrate species and also provide better refuge for indigenous fish species and frogs.

OBSERVATIONS AND RECOMMENDATIONS

1. Given the friable nature of the ground and the effects of sedimentation due to overgrazing in this area, it is likely that the proposed dam will result in a reduction of sediment deposition in the downstream reaches. This will improve the heterogeneity of substrate types in the riverbed leading to greater habitat diversity for invertebrate species and hence refuge for a greater variety of species.
2. Under no circumstances should any species of alien fish be introduced into the impoundment or river system.
3. Further in-depth studies on certain mayflies and caddisflies would be desirable.
4. Funding should be made available for setting up a routine monitoring process so that biodiversity changes in the aquatic environment can be recorded.
5. The construction of an impoundment will have minimal negative impact on the diversity of the ubiquitous macroinvertebrate fauna downstream of the dam. The presence of a large body of water holding surface water for a longer period of time annually than the natural river-course will lead to an increase in certain ubiquitous colonizer species of macroinvertebrates that are able to exploit the lentic conditions.

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