

1 Introduction

1.1 The conservation importance of the Nylsvlei floodplain

The Nylsvlei is a floodplain on the Nyl River between the towns of Modimolle (previously Nylstroom) and Mokopane (previously Potgietersrus) in Limpopo Province, South Africa. South Africa is a relatively dry country and competition between water requirements for development and for the environment is common - the Nylsvlei floodplain is one such area where there have been conflicts. The Nylsvlei floodplain has been recognised for its conservation value by conservationists and by certain government bodies such as the Department of Water Affairs and Forestry (DWAF) and has also been internationally recognised as an important wetland under the Ramsar convention on wetlands since 1998.

The case for research and conservation efforts into the Nylsvlei floodplain is a strong one: Nylsvlei supports 61% of the breeding population of inland waterbirds south of the Zambesi and Cunene Rivers and 92% of the Southern African waterbird species have been recorded here at some time (Tarboton, 1991). Flood events attract over 80 000 birds to the floodplain (Batchelor & Tarboton, 1981); 102 aquatic bird species have been recorded at Nylsvlei and 57 of these have been proven to breed on the floodplain (Tarboton, 1987). Twenty-three species on the South African Red Data Book-Birds list have been recorded on the floodplain, (Higgins & Rogers, 1993). Eight of these species breed on the floodplain, some breeding nowhere else in Southern Africa (anonymous, 2004). On a sub-continental scale the Nyl River floodplain, when in flood, provides a waterbird-breeding habitat rivalled only by the Pongola River floodplain in KwaZulu-Natal Province, South Africa and the Okavango delta of Botswana (Higgins *et al*, 1996).

The Nyl River floodplain is not only important for birds. The Friends of Nylsvley and Nyl Floodplain, a non-governmental organisation dedicated to the conservation and preservation of the Nylsvlei floodplain, issued a pamphlet about the Nylsvley Reserve that proclaims: “The unique Nyl floodplain is the largest

inland floodplain in South Africa... Seventy species of mammals occur [at Nylsvley], including Eland, Roan, Giraffe, Zebra, Tsessebe, Kudu, Waterbuck, Reedbuck, Warthog, Blue Wildebeest, plus 58 reptile species, 16 fish species and an estimated 10 000 insect species occur here”, Anonymous (2004). An estimated 300 to 600 tons of fish are produced during flood years, depending on the flood magnitude. The Nylsvlei is important for stock farmers as it can be used for winter grazing, because the floodplain grasses maintain their nutritive value for much of the dry winter season (Rogers & Higgins, 1993). Farmers are able to graze 10 head of cattle per hectare on floodplain grassland relative to 0.1 head of cattle per hectare on the surrounding savanna.

The Nylsvlei floodplain also has the potential to become an important tourist destination and tourism asset for Limpopo Province, with potential to create much-needed jobs - the floodplain is very popular with bird watchers particularly in years when the floodplain is inundated.

1.2 The flooding regime of the Nylsvlei floodplain

The Nylsvlei floodplain is a highly cyclic system in terms of flows with many species depending on alternating periods of high and low flows (Morgan, 1996). The rocky nature and generally steep inclination of the valleys in the Nyl River catchment, promote a rapid runoff of rainwater. Relatively little storage occurs and this together with the variable and localised nature of much of the rainfall, leads to erratic and highly seasonal input of water to the Nyl River. It is not uncommon for the channel to dry out during drought periods. The high rate of evapotranspiration and ponding losses specifically, ensures that floodwaters do not exit the floodplain every year and the floodplain often becomes an inland delta. From historical records, it has been found that the channel is inundated 7 out of 10 years, the low elevation floodplain grasslands 4 out of 10 years and the entire floodplain, 6 out of 10 years (Higgins *et al*, 1996). The importance of this erratic flow regime is underscored by the finding that major flood events have a tendency to attract higher numbers and more species of breeding water birds when

preceded by a dry, rather than a wet season the previous summer (Tarboton and Batchelor, 1981).

In seasons of above-average rainfall, particularly when there has been a carry-over of water in the Nyl River from the previous wet season, some 9000 to 16000 hectares of the Nyl River valley can be inundated. These floodwaters can persist for some months into the dry season and even occasionally into the following wet season, though more frequently the waters gradually recede until only the deeper parts of the main channel retain water.

1.3 Location and description of the Nylsvlei floodplain

The Nylsvlei floodplain is located between the latitudes 24°15'S and 24°50'S, and longitudes 28°10'E and 29°05'E in Limpopo Province, South Africa (Figure 1.1). The Nylsvlei floodplain comprises the southernmost portion of the Mogalakwena River catchment flanked by the Waterberg foothills to the north and west and the Springbok Flats to the south and east (Figure 1.3). The Nylsvlei floodplain lies on the African plateau at an altitude of approximately 1100m above sea level. The Waterberg foothills rise to almost 1600m in the Nyl River catchment and contribute most of the runoff that supplies the floodplain with water. The Springbok Flats is a vast featureless area, which contributes very little runoff to the Nylsvlei floodplain.

The Groot and Klein Nyl Rivers join near Modimolle (previously Nylstroom) and from here, the river now called the Nyl River, flows northeast within a relatively narrow floodplain (<1.8km wide) (Tooth *et al*, 2002) across the low-gradient Springbok Flats being confined to the synclinal basin in this area (Figure 1.3). It enters the Nylsvley Nature Reserve, the channel size decreasing continuously until the channel completely disappears forming a flat floodplain at Mosdene. From here onwards until the river flows out of the floodplain into the Mogalakwena River at Moorddift, no channel is visible. The downstream end of the Nylsvlei floodplain is marked by the crossing of the Zebediela fault by the river, part of the Thabazimbi – Murchison Lineament, a continental scale fault system (Tooth *et al*,

2002). Once in the Mogalakwena River the channel reforms and the river flows for about 250km northwards until it joins the Limpopo River, which flows into the Indian Ocean (Figure 1.1). Morgan (1996) and Frost (1987) describe the location of the Nylsvlei floodplain in more detail.

The Nylsvlei floodplain is the largest example of a Floodplain Vlei in South Africa (Rogers & Higgins, 1993), is approximately 24 250ha in extent and includes the Nylsvley Nature Reserve which preserves about 3 000 ha of the floodplain (Higgins & Rogers, 1993).

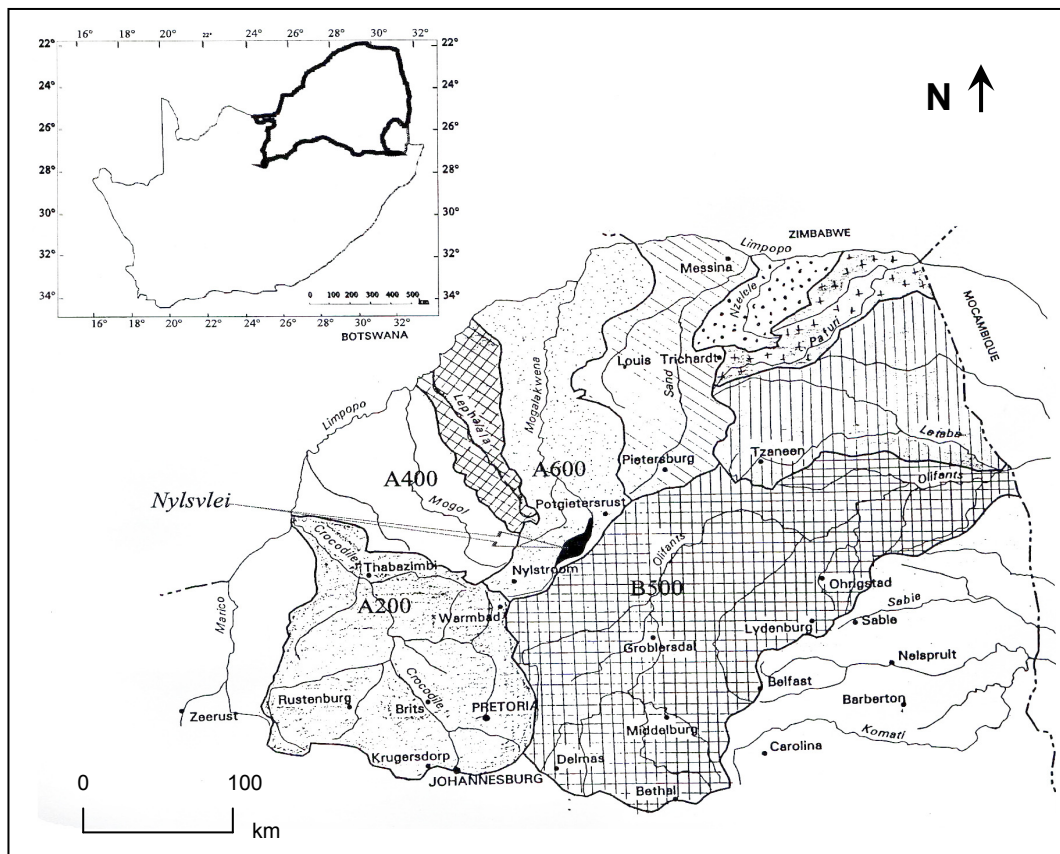


Figure 1.1: Location of the Nylsvlei floodplain in the Limpopo Drainage region (after Morgan, 1996)

The geology of the Nylsvlei region is complex, consisting of a variety of igneous, sedimentary and metamorphic rocks of very different ages. The youngest rocks

are those of the Karoo Sequence which rest in a downwarped basin made up of the much older rocks of the Pretoria and Rooiberg groups. The Waterberg Plateau and its foothills, west of the Springbok Flats, consist of sedimentary rocks. The Nylsvlei floodplain lies in a basin formed by subsidence of the Zebediela Fault (Tooth *et al*, 2002).

1.4 Climate of the Nylsvlei floodplain

The Nylsvlei floodplain lies in the bushveld, which has a warm climate with a mean annual temperature of 18.6°C (Frost, 1987). According to Frost (1987), maximum daily temperatures at the Nylsvley Reserve range from a mean of 29°C in December/January to 21°C in June/July while minimum daily temperatures vary between approximately 17°C in December/January and 4°C in June/July.

The average annual rainfall for the Nylsvley Reserve is approximately 620mm and is highly variable: annual rainfall can vary between 250mm and 1100mm within a 15 to 21 year cycle (Tooth *et al*, 2002). The annual wet season extends from November to April, the summer months, and about 85 percent of the annual rainfall occurs during these months. Most of the rainfall falls in the form of heavy thundershowers, which develop in the middle of the day over the highveld to the south-west and proceed northwards in a regular fashion against the prevailing north-easterly surface winds, usually reaching Nylsvlei and the surrounding areas in the late afternoon or evening. These storms are formed by the convergence of a rising air stream of warm, moist air advected from the north-east, and a mass of cooler subsiding air from the upper, predominantly south-westerly air stream (Preston-Whyte and Tyson, 1988). These storms vary widely in extent and large differences in precipitation can be measured over small distances on a particular day. The average rainfall for the weather stations in the area show similar trends over the long term, but small, consistent differences in annual rainfall do occur. The average annual rainfall is highest over the Waterberg Plateau, particularly along its southern margin, declining gradually with decreasing elevation and distance from the plateau (Frost, 1987). Intraseasonal variations in rainfall can also be high and the occurrence of a summer drought (defined as one or more

months during the period December to February receiving less than 50mm of rain) can occur in 50% of years (Frost, 1987).

Tarboton (1987) correlated catchment rainfall with flooding regime and found that a flood event in the floodplain is generally guaranteed if the rainfall in a season is more than 110% of the long-term average, and generally does not occur in years when rainfall is below average. Flood events can occur in below average rainfall years after brief high-intensity rainfall periods.

1.5 Vegetation of the Nylsvlei Floodplain

Two types of savanna system surround the Nylsvlei floodplain, *Combretum* savanna and *Burkea* savanna, both described as nutrient poor broad-leaved savannas (Scholes and Walker, 1993). The productivity and habitat heterogeneity of these savannas is a lot lower than that of the Nylsvlei floodplain, ensuring that grazers and browsers are attracted to the floodplain from the surrounding areas, substantially increasing the carrying capacity of the region (Higgins *et al*, 1996).

Vegetation along the Nylsvlei floodplain is differentially distributed along three spatial directions: distance from the channel, elevation above the channel, and distance downstream. Flooding frequency, duration and depth all decrease in these directions, especially the last two, and plant species distribution is a manifestation of species tolerance to flooding and drought fluctuations (Birkhead *et al*, 2004). The hydraulic models were developed with deliberate spatial and temporal resolutions, based on the flooding regime, to enable linking of flood occurrences to biotic processes in future studies (discussed in Chapter 8).

Higgins *et al* (1996) published a paper reviewing information on the Nyl River floodplain as a functional unit in the landscape. Their findings relevant to this study with regard to the channel, floodplain, riparian fringe levees, hydromorphic grasslands and sodic areas are summarised in the next five paragraphs.

Inundation in the channel (Figure 1.2) occurs to at least 0.5m for the growing season of most years, where the channel exists in the upper reaches of the floodplain. Channel vegetation consists of submerged species, floating leaved species, and monospecific stands of *Phragmites australis* reeds. As the channel is flooded more often and for longer periods of time than the other landscape units, it serves as a refuge for aquatic plant and animal species, allowing them opportunities to spread into other landscape units and complete their lifecycles during flood events. Flooding occurs in the channel approximately seven out of every ten years and can persist for three to four months.

The floodplain (Figure 1.2) is the most well researched landscape unit and is inundated during flooding events. The Nylsvlei floodplain is characterised by the deposition of fine-grained sediments from overbank flows. The floodplain has been divided into four finer scale landscape units, with elevation above the channel being the environmental variable that correlates most strongly with the observed vegetation community pattern of these finer scale units. Flooding of the channel and the floodplain landscape elements occurs approximately four out of every ten years, persisting for at least fifty days.

The riparian fringe levees are wedge shaped ridges of sediment, found bordering the channel, with the highest point near the channel with a gentle slope away from the channel into the floodplain. These natural levees are formed by the deposition of sediment when floods overtop the channel banks. The levees are well developed in the upper reaches but disappear in the lower reaches.

Hydromorphic grasslands (Figure 1.2) border the floodplain grasslands throughout the Nylsvlei floodplain. The water table in this landscape unit is characteristically fluctuating and the soils are exposed to long periods of waterlogging from mainly upslope runoff and, occasionally, flood events. These grasslands are extremely fertile and are extensively cultivated with annual crops, mainly maize, sunflower and tobacco. The small number of woody species present is due to the fluctuating water table, which seasonally drowns woody seedlings. Flooding occurs in this

zone approximately every 3 out of 10 years and usually of duration longer than 50 days, suitable for waterbird breeding. Higgins *et al* (1996) speculated that if flooding no longer occurred in this zone it is likely that woody species would encroach into these grasslands leading to an increase in the evapotranspiration relative to ground water leaching, causing an increase in the size of the sodic areas with a loss of top soil and grassland production.

Sodic areas are found in patches that are often associated with the edges of the floodplain and contain hard, compact and brackish soils. These soils are characterised by a high cation exchange capacity, consequently the vegetation of the sodic units is nutrient rich and provides valuable grazing browse material for both domestic livestock and game. The sodic islands provide two distinct sub-habitats, a woody community of the raised island periphery and grassland of the central pan. Water accumulates on the impervious clay horizon creating shallow pans, which can persist for weeks.

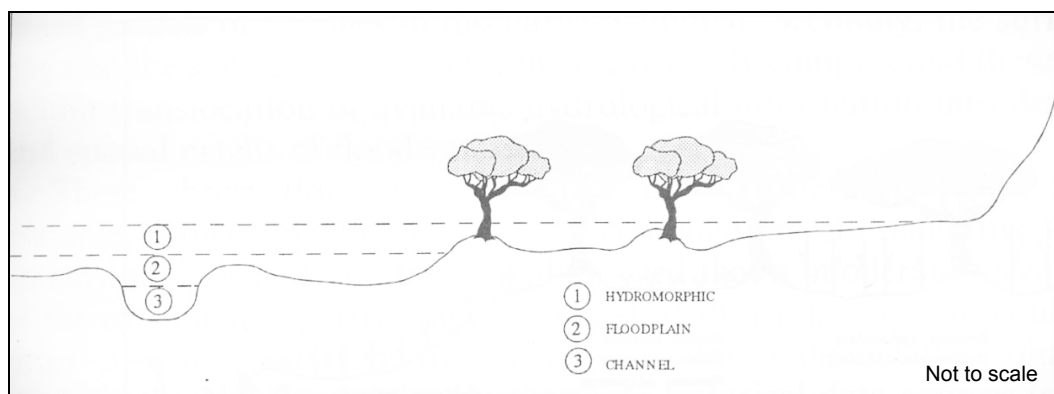


Figure 1.2: The main vegetation inundation zones (after Higgins and Rogers, 1993)

1.6 Past and future developmental threats to the Nylsvlei floodplain

The healthy ecological functioning of the Nylsvlei floodplain has become increasingly threatened over the past century by human development. Many of these threats are insidious and include the construction of dams, dykes and levees

on the floodplain itself such as the dam on the farm Deelkraal (Figure 1.3), which affect the way the floodwaters are able to spread and move downstream in the floodplain. Threats also come from developments in the catchments of the rivers that feed the floodplain and of the aquifers in the floodplain region. Apart from major dam developments in the catchments, there has also been growth in irrigation, forestry, urban areas and the construction of many small farm dams, which have affected the hydrology of the catchments and therefore the runoff to the Nylsvlei floodplain. For example, historical data sources suggest that channel flow occurred in the 1940s for 40% of the year in comparison with recent records where flow has been less than 10% of the year (Higgins *et al*, 1996). There is also ample evidence of this from the scenarios run during this project (Chapter 8). Some of the larger developments that have threatened the Nylsvlei floodplain stem from the water needs of the towns in the Nylsvlei region. The Donkerpoort dam was constructed in 1945 (Figure 1.3) to supply water to the town of Nylstroom (now Modimolle), and since then, various wellfields have been developed to augment this supply (Morgan, 1996).

According to Morgan (1996), during a severe drought in the 1960s the Potgietersrus (now Mokopane) town council investigated potential schemes to augment the town's water supply. Municipal wellfields were developed on the farms Moorddrift and Volspruit in the northern region of the floodplain in 1967 from which a large volume of water was drawn. This was only a temporary arrangement as by 1972, the Doorndraai and Combrinck dams were completed and these groundwater abstractions ceased.

Porszasz (1973) conducted a comprehensive survey of the floodplain in the early 1970s and found that severe over-exploitation of the groundwater resources was taking place in the northern region of the floodplain. The Nyl River was subsequently declared a Subterranean Water Control Area (Proclamation 56 of 26/02/1971) (Morgan, 1996). According to Morgan (1996), despite this proclamation there is evidence from studies that have been conducted since the 1970s that overexploitation of the groundwater in the Nylsvlei region is still

taking place, primarily for irrigation of crops by farmers mostly in the northern parts of the floodplain.

The north-eastern interior of South Africa, including the Nylsvlei region, experienced a severe drought in the early and mid 1980s resulting in severe water shortages for Nylstroom (now Modimolle). The town was growing very quickly at that time and some drastic steps had to be taken to avert the crisis: water was rationed and a moratorium was placed on new development in the town (Rogers & Higgins, 1993). Consulting engineers Theron, Prinsloo, Grimsehl and Pullen (1993) were appointed by the Nylstroom municipality in 1986 to study feasible alternatives to augment their water supply. They recommended the construction of a new dam on the Olifantspruit, mainly as this would be the cheapest option (Figure 1.3). This proposal caused concern amongst ecologists, as the impacts that this dam may have on the Nylsvlei floodplain downstream were potentially negative and unknown. It was feared that the dam would decrease the occurrence of small floods, which have only a brief duration but are nonetheless still important in the life cycles of certain species (Morgan, 1996). Rowlston (1991), for example, using a “combination of qualitative observations, sketchy analysis and intuition” hypothesized that a “moderately sized dam in any of the catchments, partly empty at the start of the rainy season, could absorb the entire five-year flood from the catchment”. The Transvaal Provincial Administration Directorate: Nature Conservation also objected to the proposed implementation of the scheme until its likely impact on the Nylsvlei could be investigated.

The Integrated Environmental Management (IEM) procedure was implemented, which allowed all interested and affected parties to be involved in the early planning stages of the project. In January 1991, a workshop was held in Nylstroom to allow this participation, and it was decided that construction of the Olifantspruit Dam would not proceed until an impact assessment had been completed. Three other water supply augmentation options were to be considered: those of extending the municipal wellfields, a transfer scheme from Roodeplaas Dam and a scheme to develop the groundwater reservoir near Settlers on the

Springbok Flats (Morgan, 1996). Morgan (1996) reports that this preliminary impact assessment included terrestrial ecosystems (Scholes, 1993), the Nylsvlei floodplain ecosystem (Rogers and Higgins, 1993) and potential socio-economic impacts (Marais and Bosman, 1993). Attempts were made to model flows through the floodplain using the hydrological models WRSM90 and DAMBRK, as a part of the Mogalakwena Basin Study (completed in 1992) but these were found to be inadequate for impact assessment as there was a lack of calibration data (Pitman *et al*, 1997). This particular model also did not describe how flooding occurred or what volumes of water are required for the different vegetation communities (Birkhead *et al*, 2004). In 1993, a research planning conference was convened which had the aim of summarising current research efforts and to identify priorities for future research at Nylsvlei and in the Nyl catchments (Rogers & Higgins, 1993). It was revealed that the negative impacts of the proposed Olifantspruit Dam outweighed those of the Settlers and Roodeplaat transfer schemes despite the lower cost of water with the Olifantspruit Dam alternative (Morgan, 1996). In addition, a full impact assessment was recommended by Rogers and Higgins (1993).

The pipeline alternative from the Roodeplaat Dam north of Pretoria to Modimolle was eventually built in the mid 1990s and the Olifantspruit Dam alternative was scrapped. This pipeline (which acts as an interbasin transfer) also has an effect on the flow characteristics of the Nyl River. For example, 2.3 to 2.4 Ml/day (approximately $0.85 \times 10^6 \text{m}^3/\text{annum}$) are released from the Nylstroom sewage works into the Nyl River according to Neels van der Berg (pers. comm.) who previously worked for the Modimolle municipality. This could potentially rise to $2.4 \times 10^6 \text{m}^3/\text{annum}$, calculated from the capacity of the pipeline ($3 \times 10^6 \text{m}^3/\text{annum}$) given by Beyers Havenga (pers. comm.) of DWAF and a return flow of 80% (Mark van Ryneveld, pers. comm.). This is between 2% and 5.6% of the mean annual runoff (MAR) of the catchment at the downstream end of the Mosdene reach and 2.6% and 7.5% of the MAR of the catchment at the Deelkraal gauge (A6H002).

More catchment developments are likely in the future. For example: in 1991, 180ha of land in the catchment was under exotic forestation (*Eucalypt* spp) and so was considered to have a negligible impact on the runoff from the catchment (Theron *et al*, 1991). However, it was found that 23 232ha in the catchment has forestry potential, which suggests that forestry could have a significant effect on the behaviour of the catchment (Rogers & Higgins, 1993). The steep valleys of the Nylsvlei catchment provide ideal sites for reservoir construction, and it is likely that more dams will be constructed in the catchment in the future (Higgins *et al*, 1996). A rapidly growing and urbanising population means that the Modimolle urban area will continue to expand, increasing demand for water and changing the hydrological characteristics of the catchment area.

1.7 The hydrologic and hydraulic study of the behaviour of the Nylsvlei floodplain

The Olifantspruit Dam and Nylstroom water supply saga brought the lack of understanding of the hydrological and hydraulic behaviour of the Nylsvlei floodplain and its catchments into sharp relief. A recommendation of the Mogalakwena Basin study was that further investigations should take place (Birkhead *et al*, 2004). DWAF responded by commissioning a study: “The Hydrologic and Hydraulic Study of the Behaviour of the Nyl River Floodplain”, in 1996, to which this MSc dissertation both contributed and expanded on. This study’s aim was to “develop the ability to model the hydrology and hydraulics of the Nyl River Floodplain for the purpose of predicting impacts on the floodplain, and to complement other biological and ecological work” (Birkhead *et al*, 2004).

The Terms of Reference for the project were for a five-year project period, beginning in 1997 and ending in 2001. This included an adequate period to collect hydraulics data essential for model calibration and verification. After the large floods of 2000, the study was extended by a year to allow time to incorporate the extensive flooding that occurred in 2000; to allow for the delay to the topographical survey which was scheduled for the first year of the study, but only undertaken in 2001; and to provide additional time to develop a methodology that

suitably utilises the high resolution topographical survey data in the hydraulic modelling (Birkhead *et al*, 2004).

The main purpose of this project was the development of computational models for simulating the hydrological and hydraulic behaviour of the Nyl River Floodplain. The models not only provide the means to predict the impacts of water resource developments in the upper catchments on the floodplain, but also provide results at appropriate scales for determining ecological impacts associated with an altered flow regime (Birkhead *et al*, 2004).

The study consisted of two parts, a study of the hydrology of the floodplain catchments, and a study of the hydraulics of the floodplain itself. The hydrological study was carried out by Stewart Scott International (Pitman and Bailey, 2003; Bailey, 2003) and the hydraulic study was carried out by the Centre for Water in the Environment (CWE) at the University of the Witwatersrand, Johannesburg (of which I was a member) and Streamflow Solutions cc (Birkhead *et al*, 2004). The hydrological model provided flows from rainfall in the catchments at the floodplain margin (described in Chapter 6). The hydraulic model input these flows at the floodplain margin and output flows downstream, inundation extents and depths.

The study region of the model occupies approximately the southern half of the total length of the floodplain (Figure 1.3). This region was determined early in the project by Birkhead and James (Birkhead *et al*, 2004) in close consultation with DWAF and reasons for the choice are described by Birkhead *et al* (2004):

- Inflows at the upstream boundary of the hydraulic model (Nyl River) are provided from hydrologic modelling, and the proximity of this boundary to flow gauges for hydrologic model calibration is desirable. The hydrological model should also include all areas likely to generate significant runoff.
- The Nyl River flows through large culverts under the N1, providing a suitable location for stage recording and flow gauging.

- Although the floodplain does extend upstream of the N1, it is not extensive.
- The Nylsvley Nature Reserve is the most ecologically important section of the floodplain and where hydraulic prediction is most important. The predictions, however, require accurate routing through the complex upstream section of the study area. The channel length of the Nyl River flowing through this upper section is 19.4km; the floodplain displays a complex topography, and includes artificial structures such as levees, roads, and impoundments.
- Flooding is more frequent in the upper Nyl Floodplain, the extent of which depends on flow attenuation with distance downstream and local topography. Flows were only recorded at de Hoop during the 1999/2000 and 2000/2001 hydrological years.
- Resources for topographical surveying constrained the downstream extent of the study area to route 519 at Mosdene.

This study area was further split into three separate reaches separated by two road crossings of the floodplain due to the large amounts of survey data that would be more easily handled in smaller quantities and to facilitate the manageable development of hydraulic models of smaller parts of the floodplain. The three reaches are shown in a schematic diagram in Figure 1.4:

- Middelfontein (N1) to the Nylsvley Nature Reserve
- Nylsvley Nature Reserve
- Vogelfontein (downstream boundary of the Nature Reserve) to Mosdene at the Naboomspruit – Crecy road crossing

The hydraulic models run in sequence, with outflow from the upstream model reach becoming inflow for the adjacent downstream model reach. The hydrological model of the catchments developed by Stewart Scott consulting engineers (Pitman and Bailey, 2003; Bailey, 2003) provided modelled flows as well as observed flows routed to the floodplain margin for the Nyl River at Middelfontein and the four tributaries (Middelfonteinspruit, De Wetspruit ,

Eersbewoondspruit (referred to by Birkhead *et al* (2004) as the Blindefontein) and Bad se Loop). The schematic diagram (Figure 1.4) also shows additional inflows and outflows due to rainfall on the inundated areas, losses to evapotranspiration and infiltration into the floodplain soils and storage in depressions and artificial impoundments where losses occur later when the floodplain waters recede.

The aim of this Masters dissertation was to participate in the development of the hydraulic model and, after a calibrated and verified model was available, to run different catchment scenarios to estimate their impacts on floodplain inundation. The hydraulic models of the three reaches were set up together with Birkhead: Birkhead set up the Nylsvley Nature Reserve and Vogelfontein – Mosdene reaches and I set up the Middelfontein reach under the supervision of Birkhead (Chapter 6). I also conducted a field study to determine infiltration losses on the inundated floodplain (Chapter 5) and analysed evapotranspiration data to determine these losses on the inundated floodplain (Chapter 4). I applied all the hydrological and hydraulic models together to demonstrate the impact on floodplain inundation of various catchment development scenarios (Chapter 7) and analysed these with specific reference to the wild rice (*Oryza longistaminata*), which has specific inundation frequency, duration and depth requirements (Chapter 8). The wild rice has been identified as the species with the most diagnostic potential in terms of response to flooding and has been extensively studied on the Nylsvlei Floodplain.

1.8 Summary

The Nylsvlei floodplain is one of the most important floodplain environments in South Africa, due to the large number and species of birds it attracts, and the populations of mammals, reptiles, fish, plants and insects it supports. The Nylsvlei floodplain is a highly dynamic environment with some years experiencing flood events that last for months or even years and other years when there is no flood at all. The water crisis experienced by Nylstroom (now Modimolle) in 1980s and the proposal to construct a dam on the Olifantspruit made it clear that more research was required into the workings of the Nylsvlei floodplain. Although the dam was

never built, there have been numerous other developments in the floodplain catchments as well as on the floodplain itself, which have made some form of model to evaluate scenarios desirable. This Masters project forms part of such a project to develop a model of the hydrology and hydraulics of the floodplain.

1.9 Dissertation preview

Chapter 1 discusses why the Nylsvlei floodplain is important ecologically, briefly explains the functioning of the floodplain and the reasons for conducting this study.

Chapter 2 discusses why models are useful tools for environmental impact assessment and reviews various models previously used to model the Nyl River catchments and floodplain and why they were not suitable for this task. It also reviews a few similar projects in the literature and the modelling methods used.

Chapter 3 explains the process undertaken by the CWE and DWAF to collect the stage, flow and topographical data that was required to set up a hydraulic model of the Nylsvlei floodplain.

Chapter 4 deals with evapotranspiration losses to floodwaters inundating the floodplain, which had to be accounted for in the hydraulic model. Various methods of determining evapotranspiration are reviewed and the method used by Blight (2002a) to determine evapotranspiration losses on the Nylsvlei floodplain is described and average monthly evapotranspiration rates for each month are recommended.

Chapter 5 deals with infiltration losses to floodwaters inundating the floodplain, which also had to be accounted for in the model. Various previous studies undertaken on the floodplain are reviewed. Infiltration rates on the floodplain were measured during this project and these are described here and infiltration rates are recommended for the floodplain.

Chapter 6 details the development of both the hydrological model of the catchments and hydraulic model of the floodplain. This includes the creation of a contour map of the floodplain, one-dimensional modelling of the hydraulics and drawing of inundation maps.

Chapter 7 details the development of various catchment development scenarios that were then modelled to determine their impact on floodplain inundation.

Chapter 8 discusses the effects of these catchment development scenarios on inundation on the floodplain, in terms of inundation area, depth, duration and frequency. The impact that these development scenarios would have on the wild rice grass, which populates large areas of the floodplain, was also estimated.

Chapter 9 concludes the dissertation and makes recommendations for further research into the inundation of the Nylsvlei floodplain.



Figure 1.3: Map showing the southern portion of the Nylsvlei floodplain and catchments, the location of the study area, locations of the gauging stations and rain gauges, and the then-proposed site of the Olifantspruit Dam. Location shown on 1: 250 000 map 2428 ‘Nylstrom’, produced by the Surveyor General, Pretoria

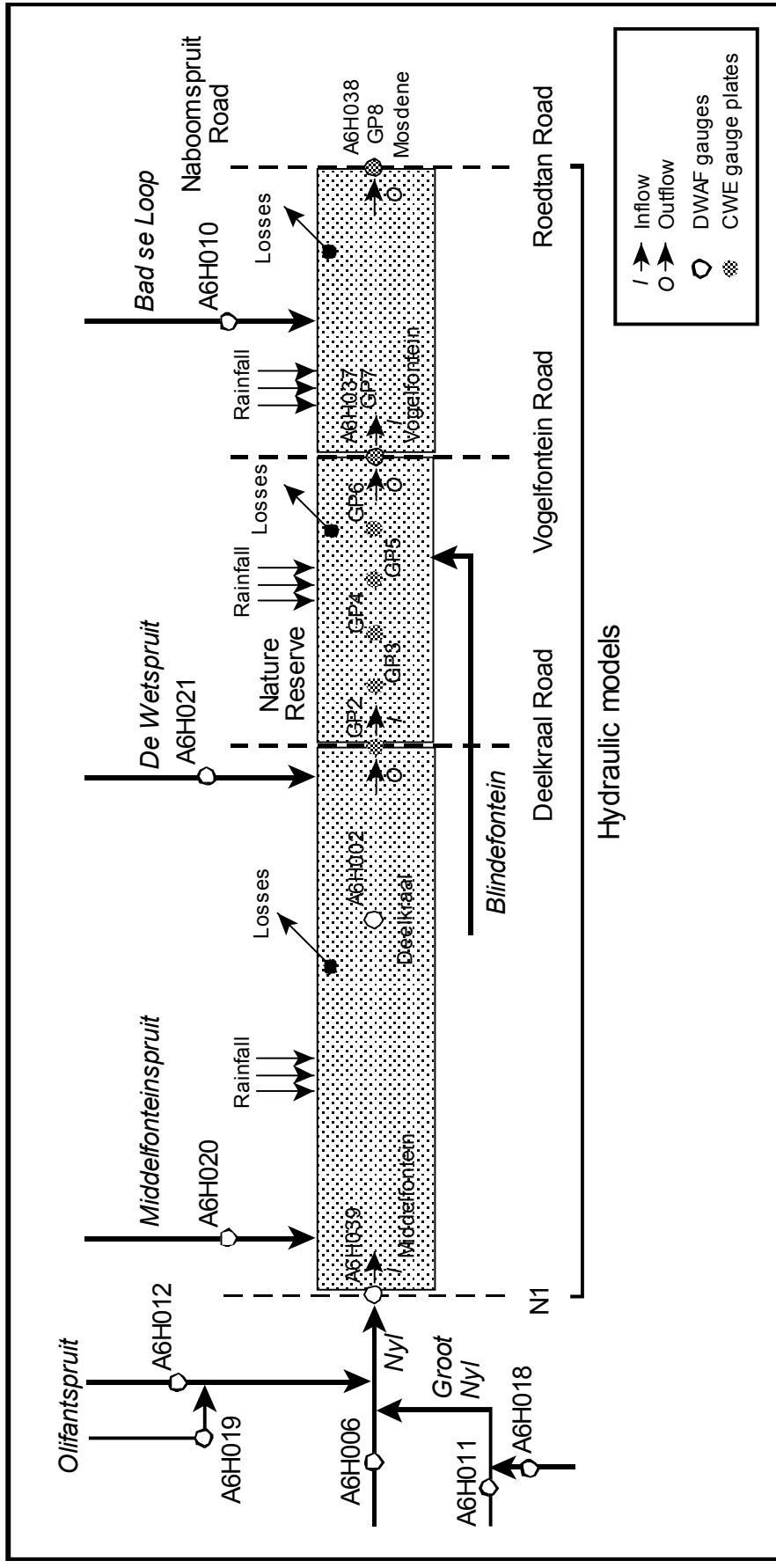


Figure 1.4: Schematic diagram of the hydraulic modelling area showing its division into three smaller regions. Significant inflows (Nyl River inflow, tributaries and rainfall) and outflows (Nyl River outflow and losses), and the location of water level gauges along the floodplain are indicated (after Birkhead *et al*, 2004)