

9 Conclusions and recommendations for further research

9.1 Conclusions

There have been increasing threats to the healthy functioning of the Nylsvlei floodplain through the supply of its water in the last 50 years or so. The project, “The Hydrologic and Hydraulic Study of the Behaviour of the Nyl River Floodplain”, of which this dissertation forms a part, was in response to these threats.

Various data were collected on the floodplain including measurement of evapotranspiration losses by Blight (2002a) using an energy balance method. These data were compared to evaporation pan data to find estimates of the average monthly daily evapotranspiration. It was found that evapotranspiration losses to floodwaters on the floodplain vary throughout the year and the Jensen and Haise (1963) and Thornthwaite (1948) empirical methods and the Pure Grassveld A pan factor (Midgley *et al*, 1994) were confirmed by the data to be good predictors of monthly average daily evaporations in a wetland environment like the Nylsvlei floodplain.

Measurements were conducted to determine losses of floodwaters to infiltration on the floodplain. Infiltration rates were found to vary with depth, being too low to measure in certain soil layers in the floodplain alluvium. As infiltration losses were not conclusively determined, they were lumped with ponding losses (such as impoundments and depressions) and accounted for in the model through a water balance exercise.

Various catchment scenarios were developed and modelled: including a virgin scenario, historical scenario, and three historical scenarios with different forms of a dam on the Olifantspruit. Two of the dam scenarios had environmental releases and the other scenario was with an infinitely large dam and no releases.

One of the dam scenarios with environmental releases included a small investigation into the optimum release duration of IFR high flows for floodplain inundation. No definite pattern was found between the duration of a high flow IFR release and floodplain inundation area, although the relative effect of these releases were greatest in dry years when the flow contribution from other tributaries was small.

A comparison of the historical scenario daily floodplain inundation area time series for the entire study area over the study period with Tarboton's (1987; 1989) qualitative descriptions showed reasonable agreement.

The temporal occurrence of various inundation areas over the study period in the Nylsvley Reserve reach were found to decrease with increasing catchment development and these decreases relative to the virgin and historical scenarios were found to become more pronounced for larger inundation areas. Decreases of up to 60% and 67% compared to the historical scenario were found for the two Olifantspruit Dam scenarios for inundation areas exceeding 12 km².

The scenarios were analysed in terms of the inundation duration requirements of wild rice for all the study reaches and the entire study area. The impact of existing catchment developments (represented by the historical scenario) was found to be small in wet years but significant in dry years. On average, inundation areas were reduced by between 7% and 12% depending on the reach compared to the virgin scenario. The various Olifantspruit Dam scenarios also showed greater impacts during dry years with inundation areas reduced by between 7% and 24% depending on the reach and the environmental release regime. It was also found that the relative contribution of the Olifantspruit to floodplain inundation of the required duration was smaller in wet years than in dry years, with average contributions to inundation areas over the study period of between 18% and 29% compared to the historical scenario depending on the reach. The temporal occurrences of exceedence of the largest area inundated for at least 25 continuous

days in each year was also investigated for each reach and were found to decrease with increasing catchment development.

The scenarios were also analysed in terms of the flooding depth and duration requirements of wild rice in the Nylsvley Reserve reach. Again, existing catchment developments have had a significant impact on the desired floodplain inundation required by wild rice especially in dry and 'normal' years, but less so in wet years. Suitable inundated areas were reduced by up to 87% (in 1991/1992) and on average by 9% over the study period, compared to the virgin scenario. The Olifantspruit Dam would have had a significant impact on the desired floodplain inundation for wild rice during dry and 'normal' years although with careful operation this impact could be mitigated. For the two Olifantspruit Dam scenarios with environmental releases, suitable inundated areas in both scenarios were reduced on average by 19% and 9% compared to the virgin and historical scenarios respectively, and by up to 61% for a constant base flow release of 30 l/s and 38% for an IFR release compared to the historical scenario in 1981/1982. An improvement in suitable inundated areas compared to the historical scenario was possible in certain years, for example in 1991/1992 an improvement of 75% to suitable inundation areas compared to the historical scenario was possible using an environmental release. The Olifantspruit is a very important tributary for the desired floodplain inundation for wild rice in dry years, but less so during wet years, which has implications for the planning of any future developments on this tributary. This was investigated using a dam of infinite capacity on the Olifantspruit with no outflows, and it was found that on average the Olifantspruit contributed to 18% and up to 69% (in 1981/1982) of the suitable inundated areas on the floodplain compared to the historical scenario.

The temporal occurrence of floodplain inundation of the desired depth and duration for wild rice was also found to decrease with increasing floodplain inundation areas and increasing catchment development. For a threshold average inundation frequency of three years, inundation areas suitable for wild rice (with the required inundation depth range, duration and minimum frequency) reduced

from 2.2 km² in the virgin scenario to 2.1 km² in the historical scenario and potentially to 1.9 km² in the Olifantspruit Dam scenarios to 1.6 km² with no flow contribution from the Olifantspruit.

This project managed to achieve the objectives of predicting the impacts of catchment development on the Nylsvlei floodplain for environmental impact assessment purposes. The model can transform rainfall into floodplain inundation on a daily time step at the required spatial resolution for predicting the impacts on the wild rice. Linking the model with the responses of the wild rice to flooding showed that it is possible to set up such links and that in the future, should the need arise, other links could also be set up for other species to study the impact of catchment development on them. The various catchment scenarios with different forms of the Olifantspruit Dam demonstrated that this model can be used as a tool to quantify the impacts of a proposed dam on floodplain inundation and could be used to minimise the impact of any new dam development.

9.2 Recommendations for further research

There is still a lack of knowledge of the nature of infiltration losses to floodwaters on the floodplain. It was shown that trying to determine infiltration losses through direct measurement is difficult and generally inaccurate. It is therefore recommended that in any future study to determine the losses to infiltration on the floodplain, that the annual cumulative mass balance method used in this study is used using inflow and outflow data for each reach. The losses to infiltration and ponding determined in this study were not accurate due to only four years of mass balance data for the Nylsvley Reserve reach being used.

The model predicts inundated areas and their variation with time; however their output has not been directly verified. A verification of predicted inundation areas could therefore be conducted during a flood through monitoring inflows to each reach, and on the same day taking GPS coordinates of the water's edge at various points in each reach and plotting these on inundation maps drawn using the

RiverCAD floodplain mapping module (obtained from measured inflows and rainfall input into the hydraulic model).

A comparison between inundated areas of depths suitable for wild rice (drawn using the RiverCAD floodplain mapping module) and the actual areas where wild rice grows could be conducted, to determine what size floods are most important for wild rice growth. The effect of catchment developments on the temporal occurrence of these floods could then be found.

A similar analysis of the impacts of catchment developments in terms of the flooding requirements of other plants, animals or birds could be conducted. This should be done in close consultation with biologists to determine the correct rules and to obtain relevant results.

A simpler model could be used to extend the Nylsvlei floodplain model to the floodplain exit at Moorddrift. A simpler model may be more appropriate due to the highly modified nature of the downstream reaches of the floodplain from farming activities and the infrequent flooding that occurs in these areas. It is recommended to consider carefully the use of a hydraulic model of the nature used in this study for the downstream reaches due to the resources required to set up such a model.