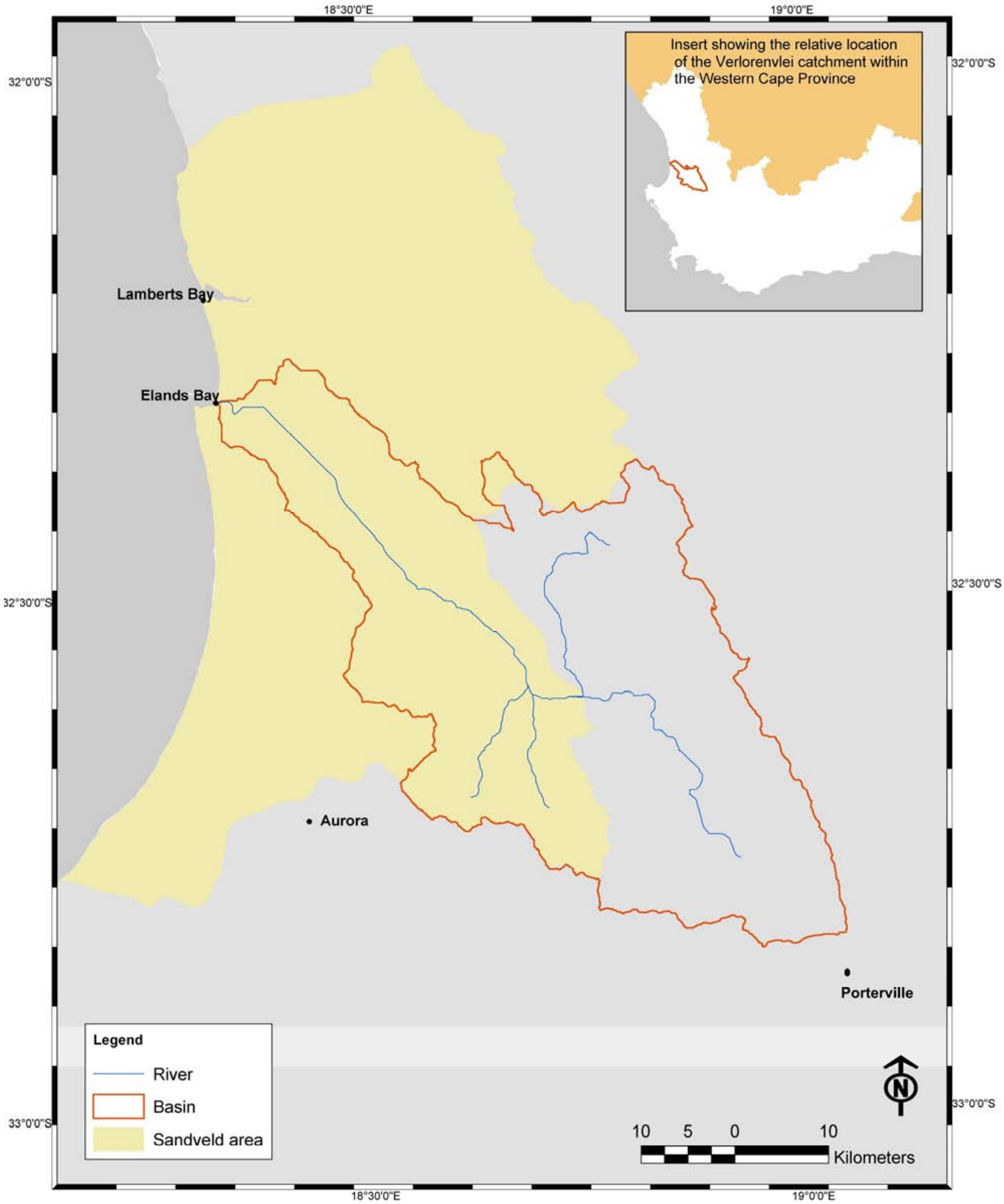


Figure 1.1 The Sandveld area and the Verlorenvlei Catchment

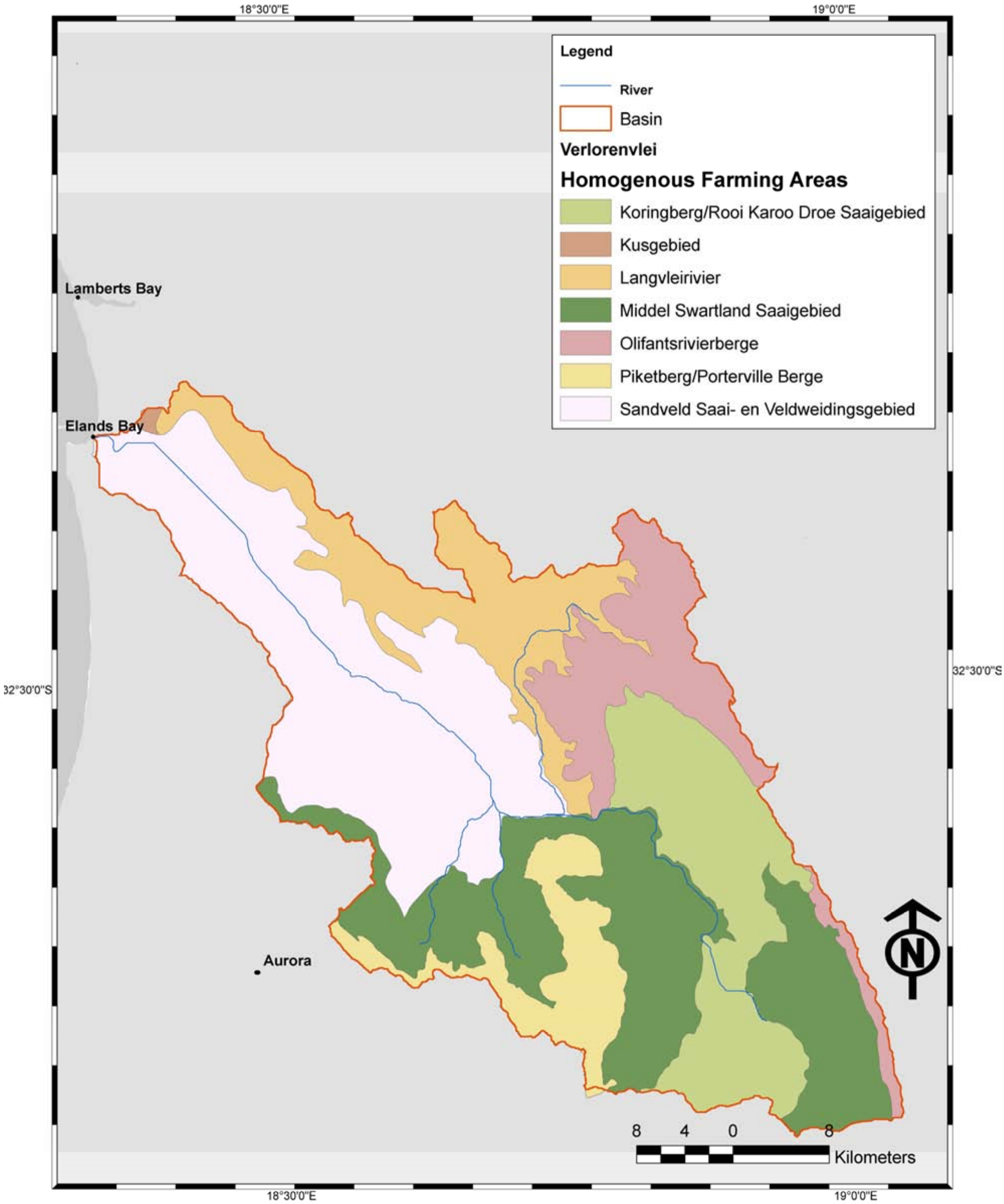


Figure 1.2 Homogenous farming areas in the Verlorenvlei catchment

CHAPTER 3: METHODS

3.1. STUDY AREA

The study area, namely the Verlorenvlei catchment, is depicted in below in Figure 3.1.

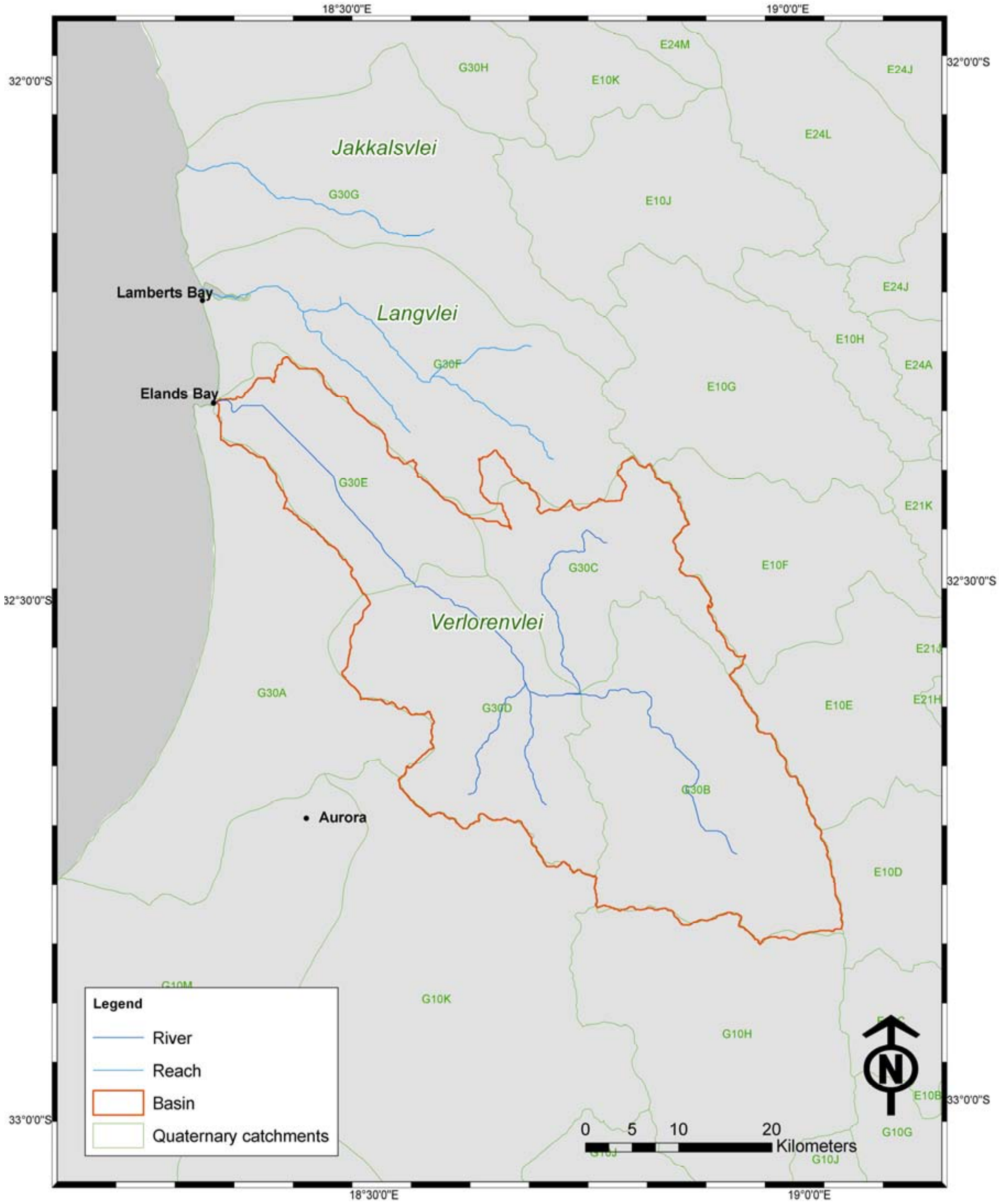


Figure 3.1 Study area consisting of the Jakkalsvlei (G30G), Langvlei (G30F) and Verlorenvlei (G30B, C, D and E) quaternary catchments.

precipitation and winds are typically strong north west in winter and south east during summer months (Maclear 1994).

Low & Pond (2003) describe how the study area vegetation type has a large range in variability from mountain fynbos (dominated by Cederberg Sandstone Fynbos and Graafwater Sandstone Fynbos) to lowland fynbos (Leipoldtville Sand Fynbos) (see Figure 3.2 and Table 3.1).

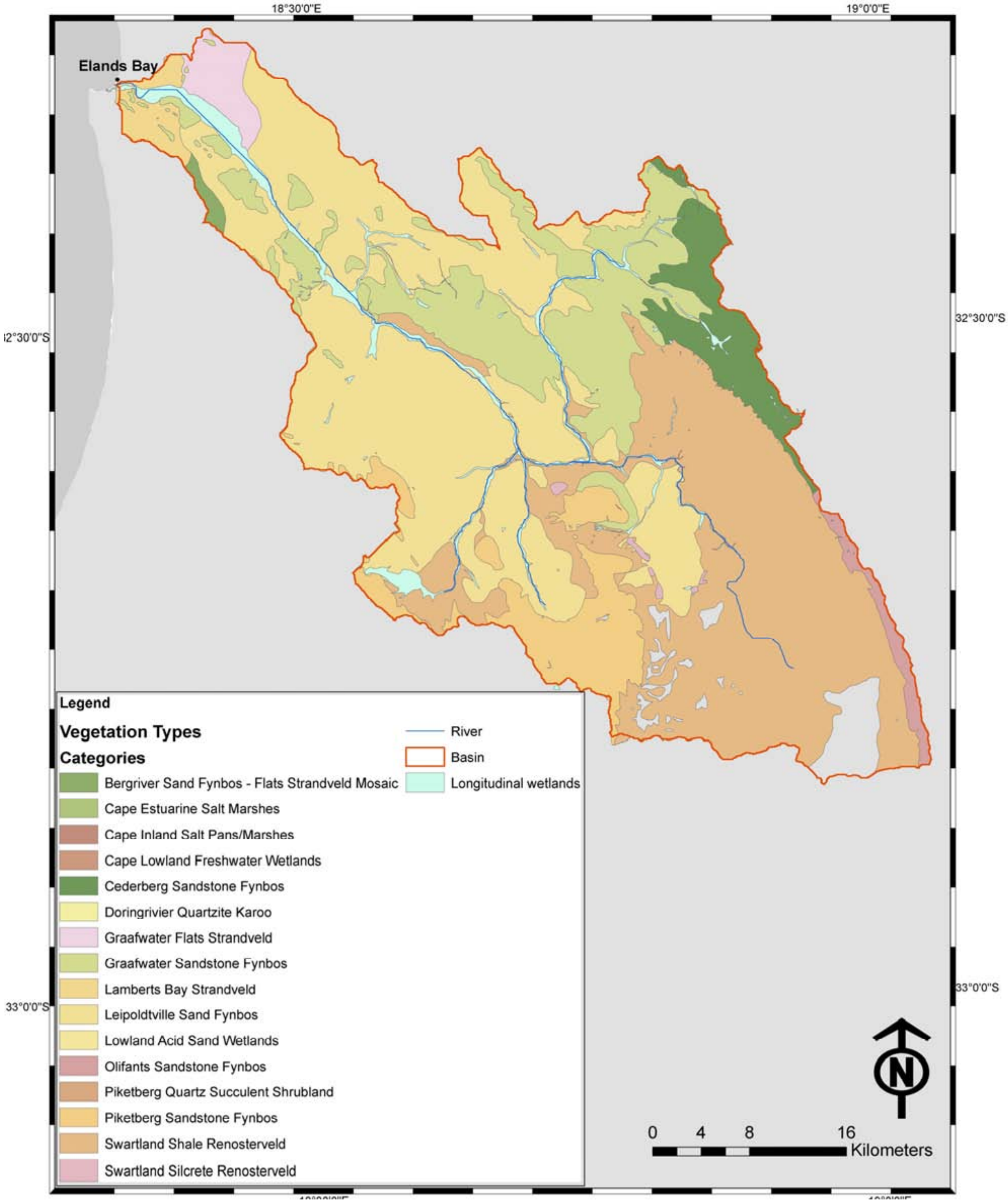
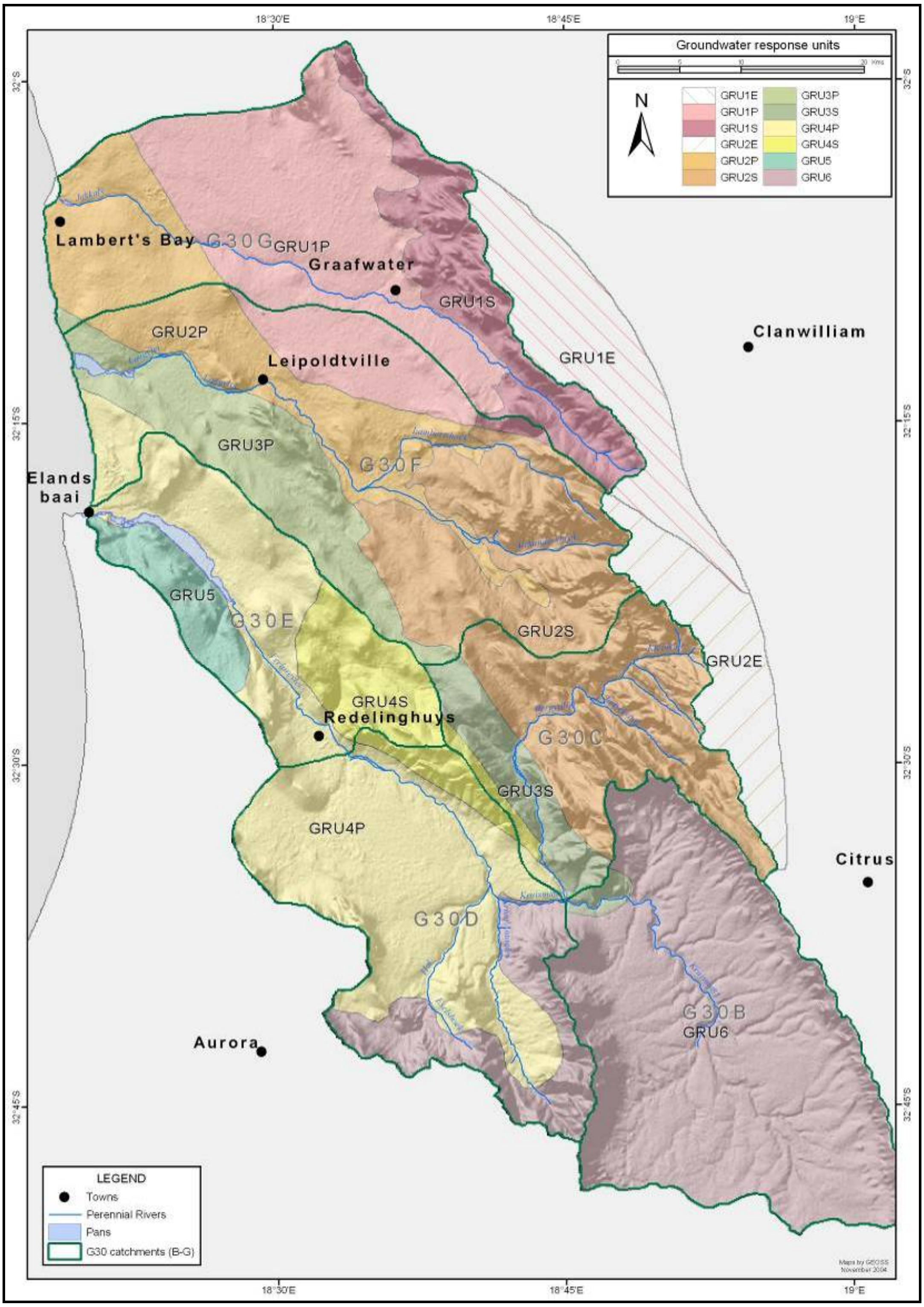


Figure 3.2 Vegetation types in the Verlorenvlei catchment area

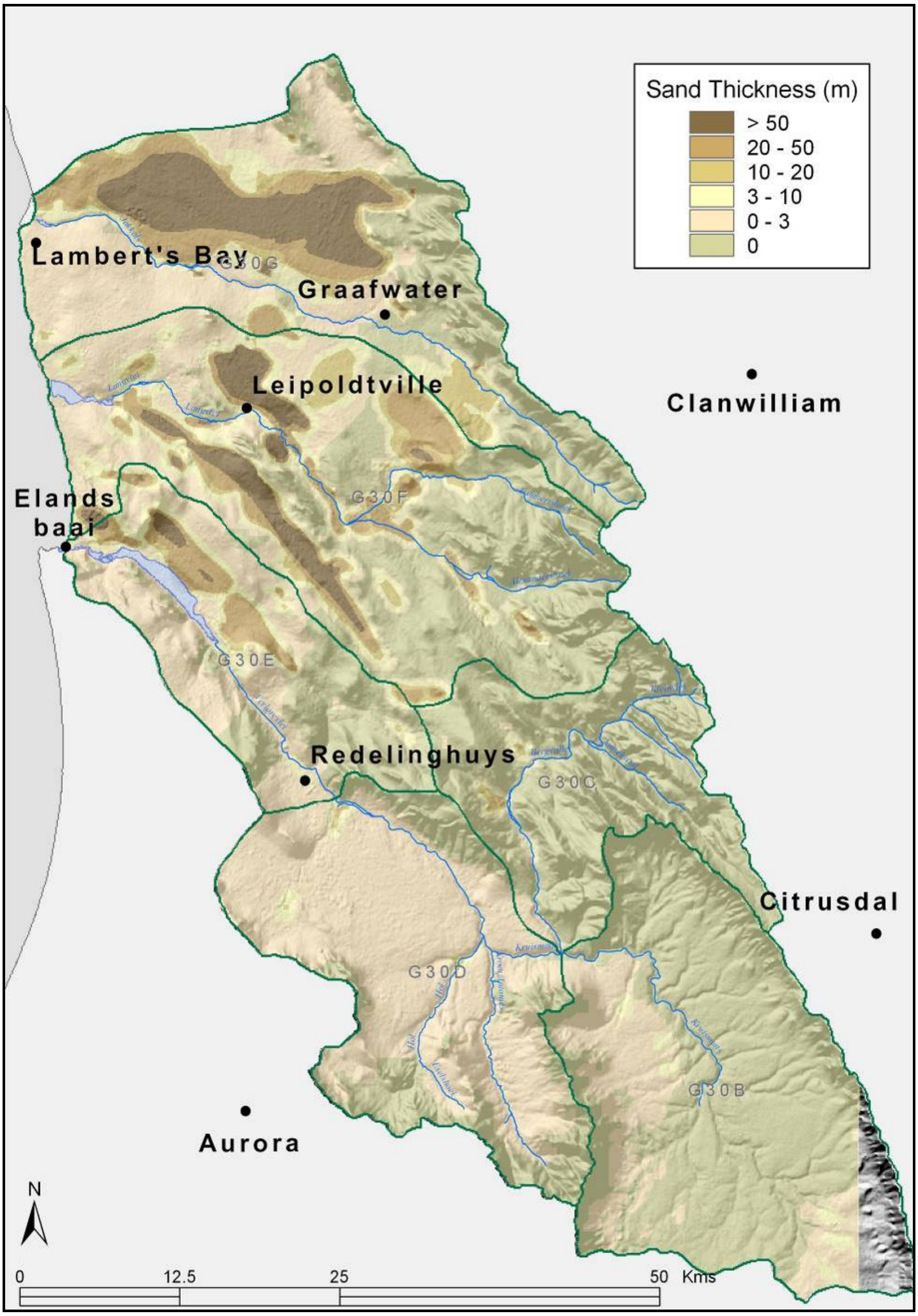


Source: DWAF (2003)

Figure 3.3 Groundwater response units for the study area

Source: DWAF (2003)

Figure 3.4 Sand and bedrock aquifers in the study area



Source: DWAF (2003)

Figure 3.5 Sand thickness in the study area

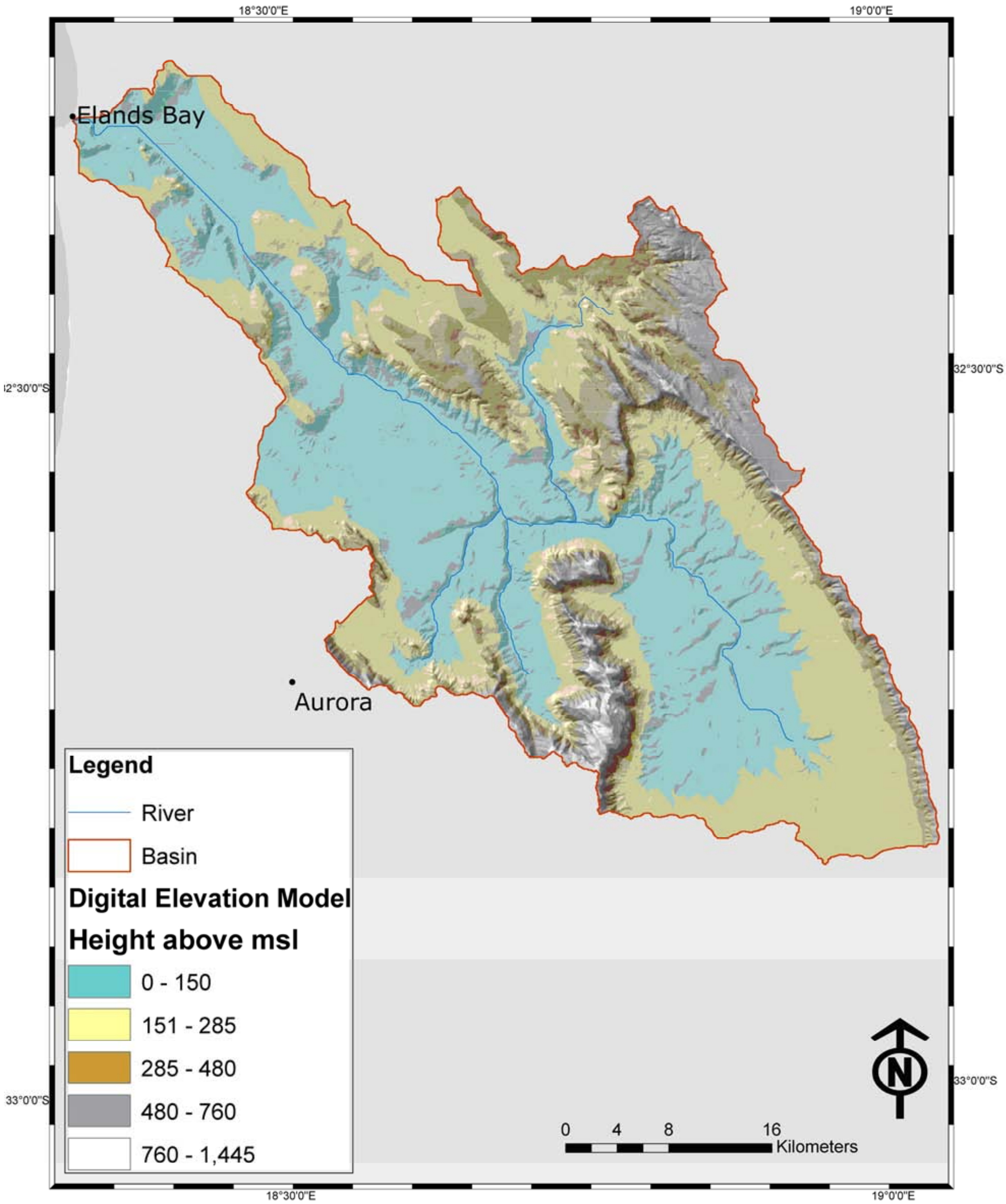


Figure 3.6 Topography of the study area

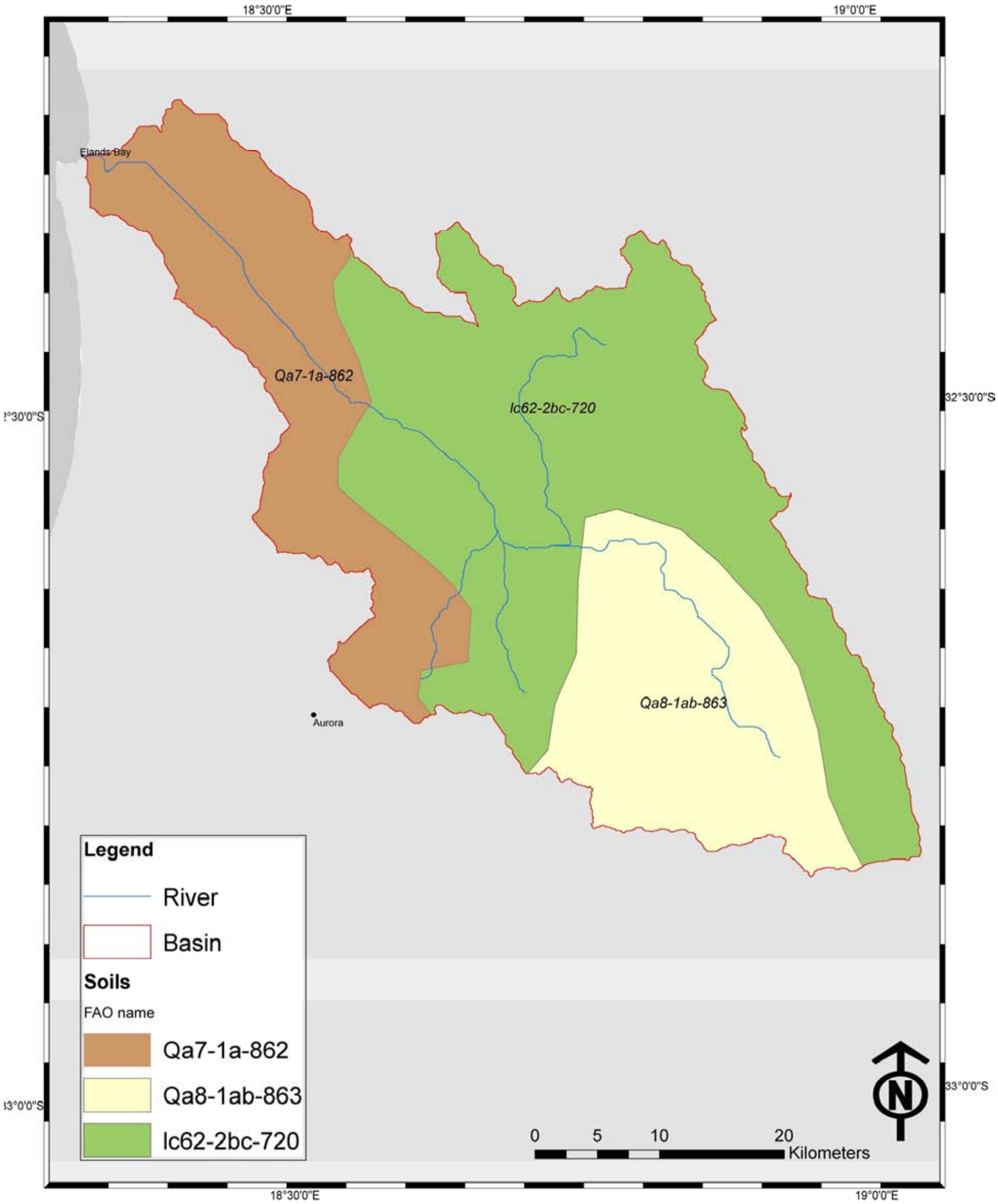


Figure 3.7 Soils of the study area

3.2.4. Land cover to land use

The land use dataset was derived from land cover data acquired from the C.A.P.E Fine Scale Planning Initiative, managed by CapeNature. Thompson & Forsythe (2006) describe the land use data acquisition process used in creating the final product.

to 22.5m x 22.5m. This method removed odd articles within uniform areas, to give a better aggregated result.

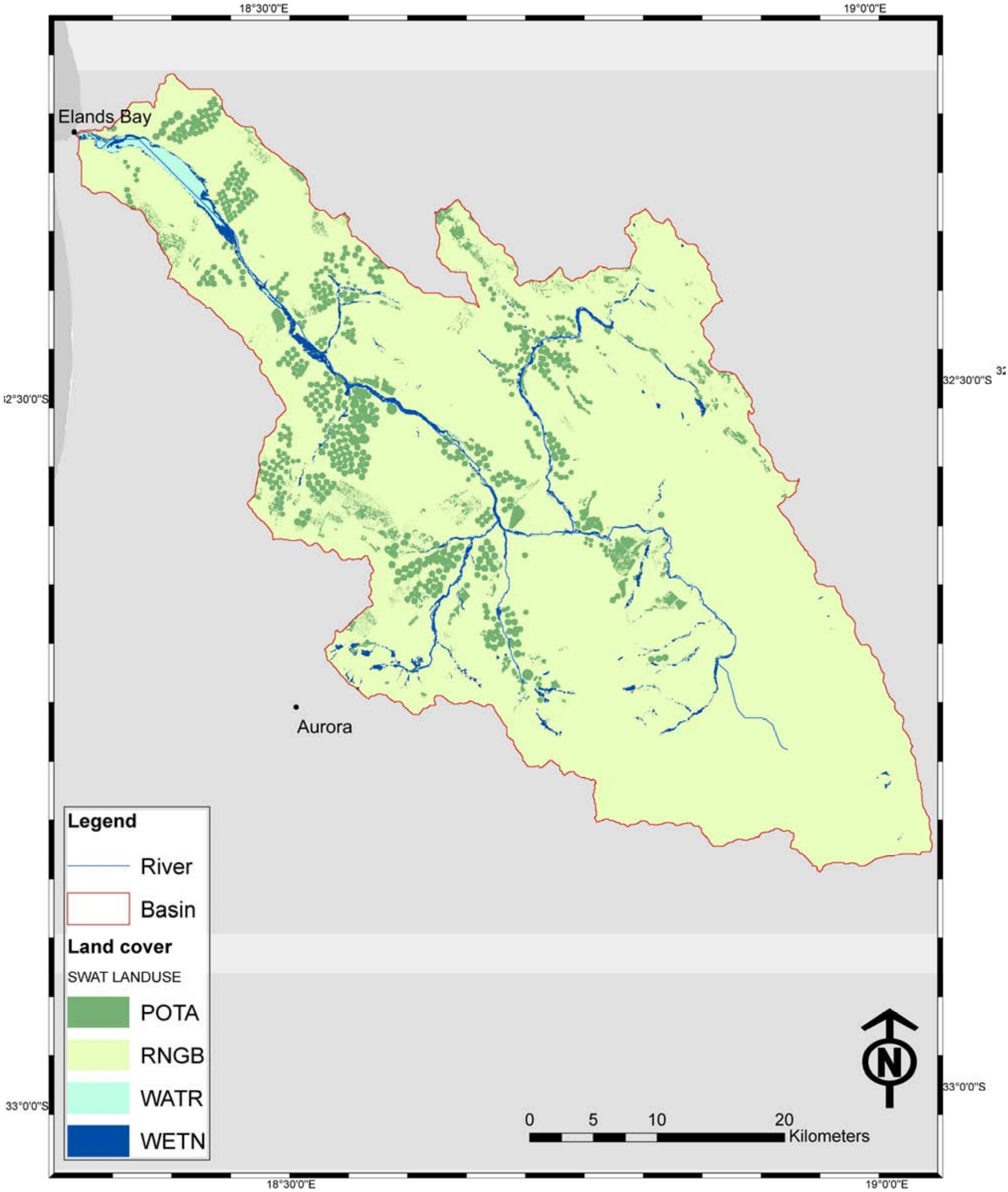


Figure 3.8 Land use map

Table 3.3 Types of weather stations in the Sandveld, used for precipitation

NAME	START DATE	END DATE	YEARS	STATION TYPE
REDELINGHUYS	1991/01/01	2004/05/01	13.34	MECHANICAL
AFGUNST	1985/07/01	2004/05/31	18.93	MECHANICAL
RIVIERA	2001/05/01	2007/07/31	6.25	AUTOMATIC
PORTERVILLE	1973/01/01	2008/06/31	36.5	AUTOMATIC

The Porterville and Riviera stations are still in working order; however the data for this study was collected at different times which reflect in the date range. Porterville's measured rainfall was incorporated into the model inputs because of it's location against the neighbouring mountains and its tendency for higher rainfall than the stations situated in the coastal floodplain.

This approach was suggested by a hydrologist (Howard 2008, pers com) as typically most of the runoff generated in this catchment would originate in the mountains. The location of the station was manipulated within the GIS to fall on the Northern edge of Sub basin 5, more or less at the same elevation and aspect as the original station location. Figure 3.11 illustrates some of the problems encountered with the available climate data. Redelinghuys and Afgunst were abandoned in 2004, while Riviera was missing data from November 2003 to May 2004. The graph compares the average monthly precipitation for each station.

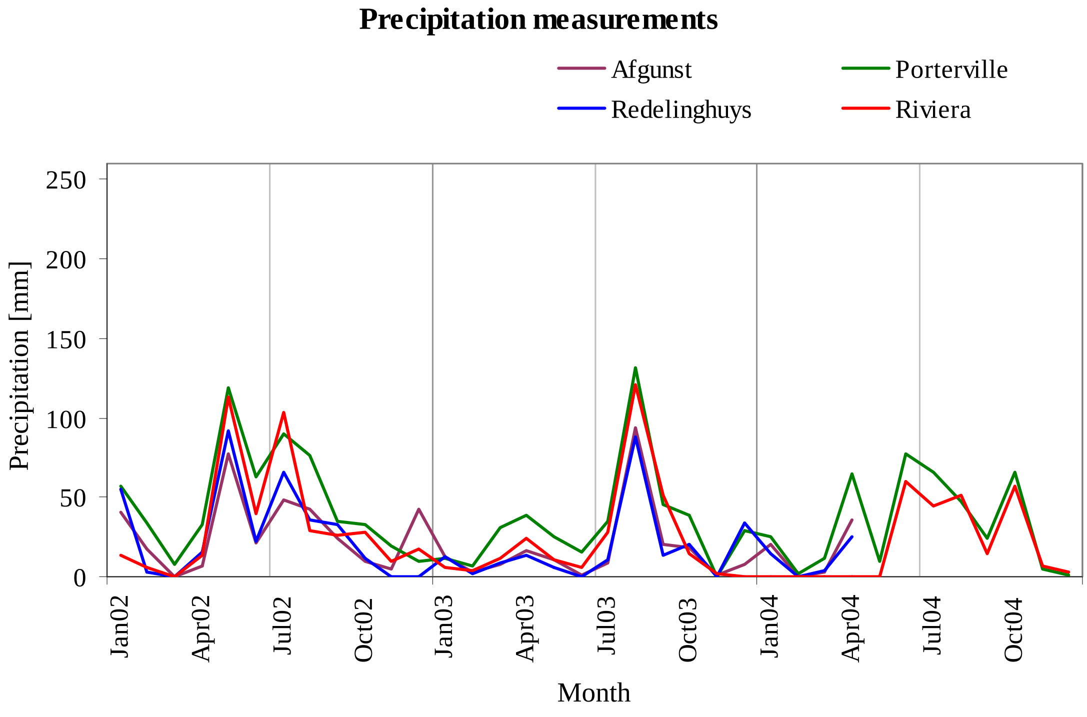


Figure 3.11 Comparison of precipitation measured at the rainfall stations

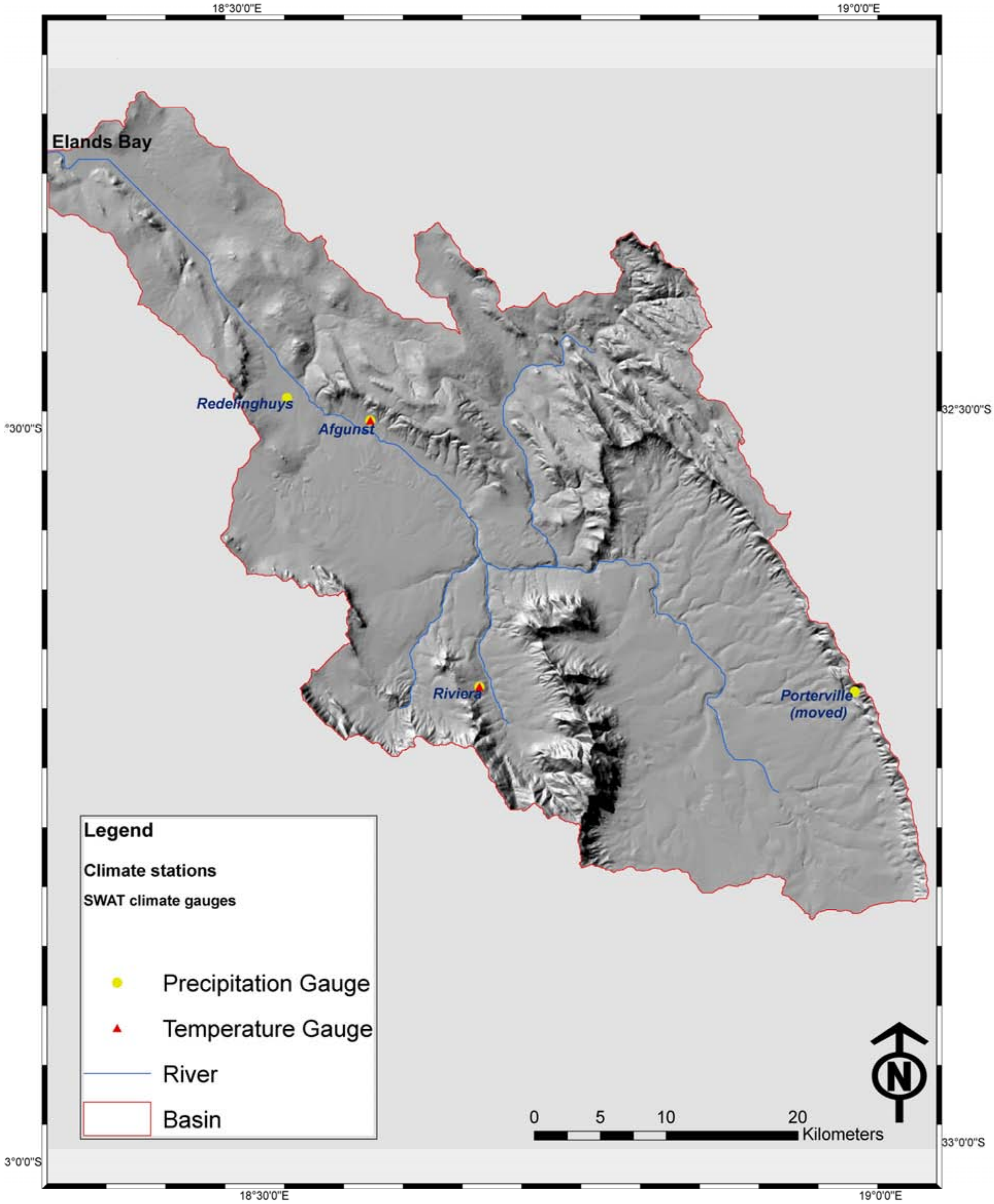


Figure 3.12 Climate station locations in the study area

3.2.5.2 Long term statistical climate data

The statistical data required for the weather generator routine was complex to acquire, with expert processing needed for some values where daily data was not available. SWAT requires daily

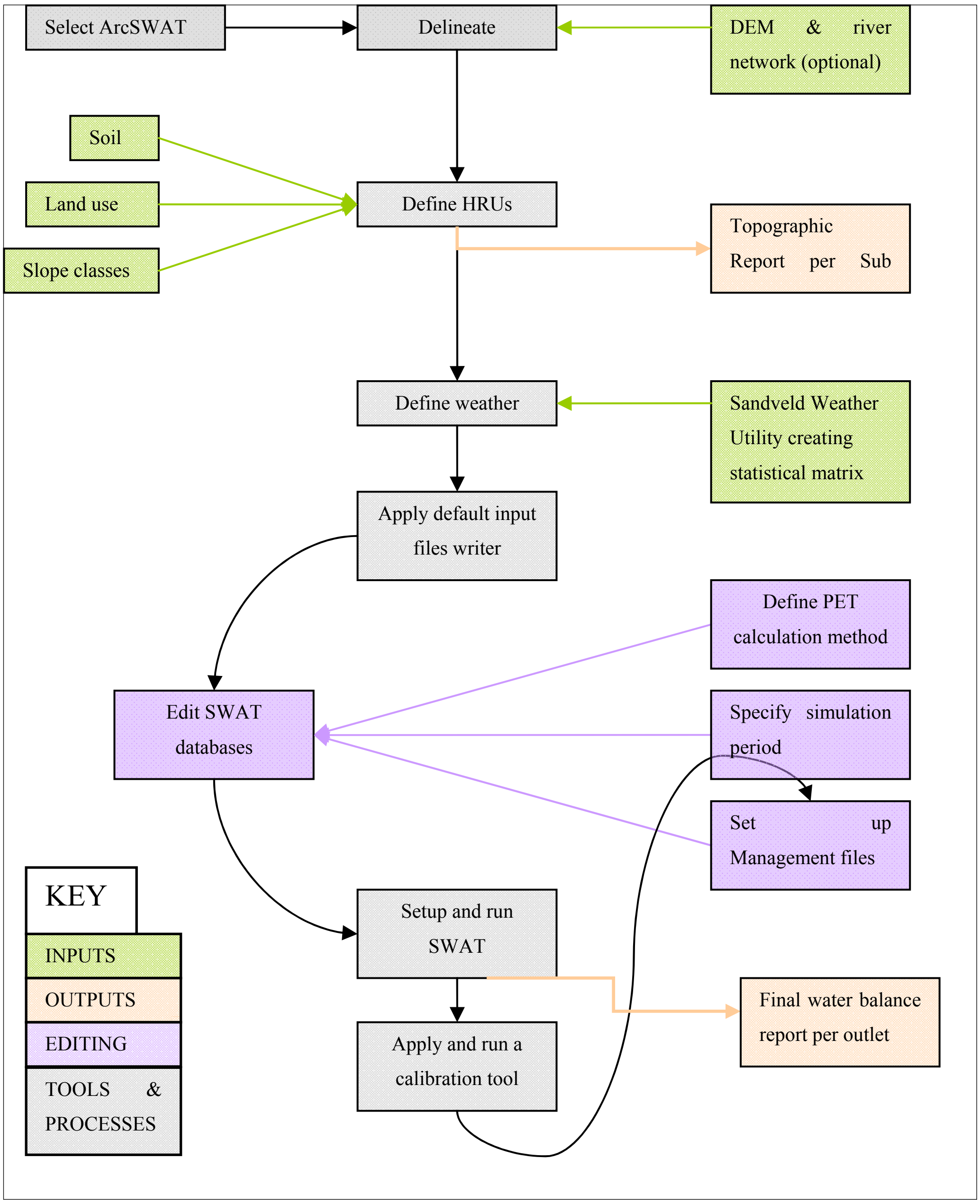


Figure 3.13 Workflow diagram to setup and run ArcSWAT

3.5.3. Setting up the model

GIS data was first collected, the DEM, soils data and land cover, each of these processed as described earlier in sections 3.2.2, 3.2.3 and 3.2.4. The SWAT menu bar (Figure 3.14) appears in the graphic user interface (GUI) of ArcGIS, and the user starts on the left hand side at the first menu option, which allows basic project and data management functions. This is where the project name and directory are opened, set up and saved.

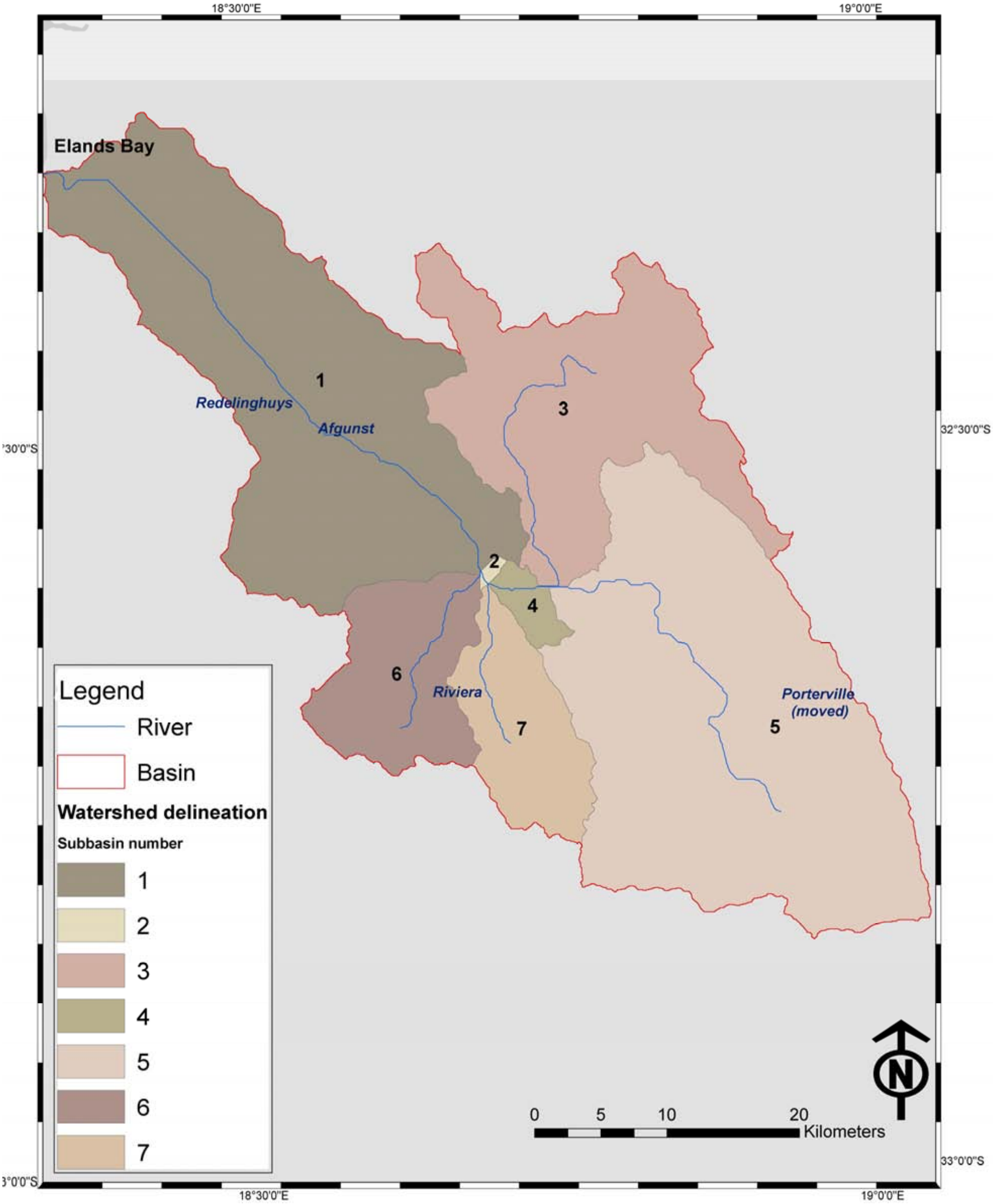


Figure 4.1 Sub basin delineation resulting from ArcSWAT

Unique hydrological response units were defined in the GIS based process described in Section 3.5.3. The final run of the software produced 16 HRU's represented in Figure 4.2. This was a reasonable number of processing units for computational efficiency. The model lumped all hydrological inputs per HRU and used representational areas for each HRU value within a subbasin.

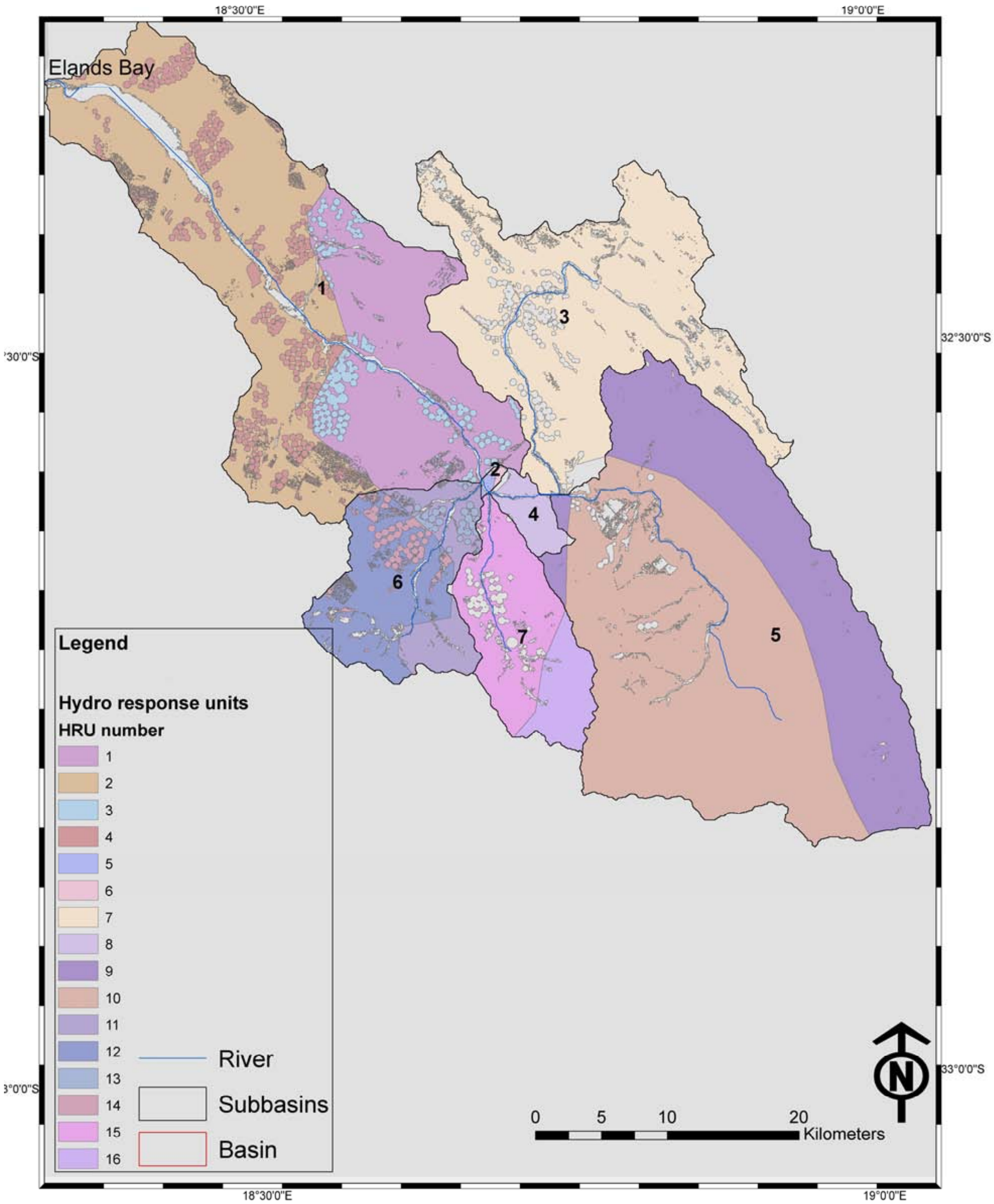


Figure 4.2 HRU results from SWAT

4.2. ARCSWAT RESULTS

A final successful run with acceptable surface flow results was achieved through the ArcSWAT interface. Simulated flow curves closely followed the measured flow at the Verlorenvlei gauge. The gauge is situated in the middle of the river where wetland dominates the shores. The photographs below in Figure 4.3 show the gauge and its position from various aspects in the Verlorenvlei.

Flow results for subbasin 5 were extracted from the output.rch files which contain the simulated flow for each reach as cumulative flow at the outlet of the reach.
Figure 4.4 shows the position of the flow gauge in relation to the rest of the catchment and the outlet monitoring point of sub basin 5.

Figure 4.3 Views of the Verlorenvlei gauge

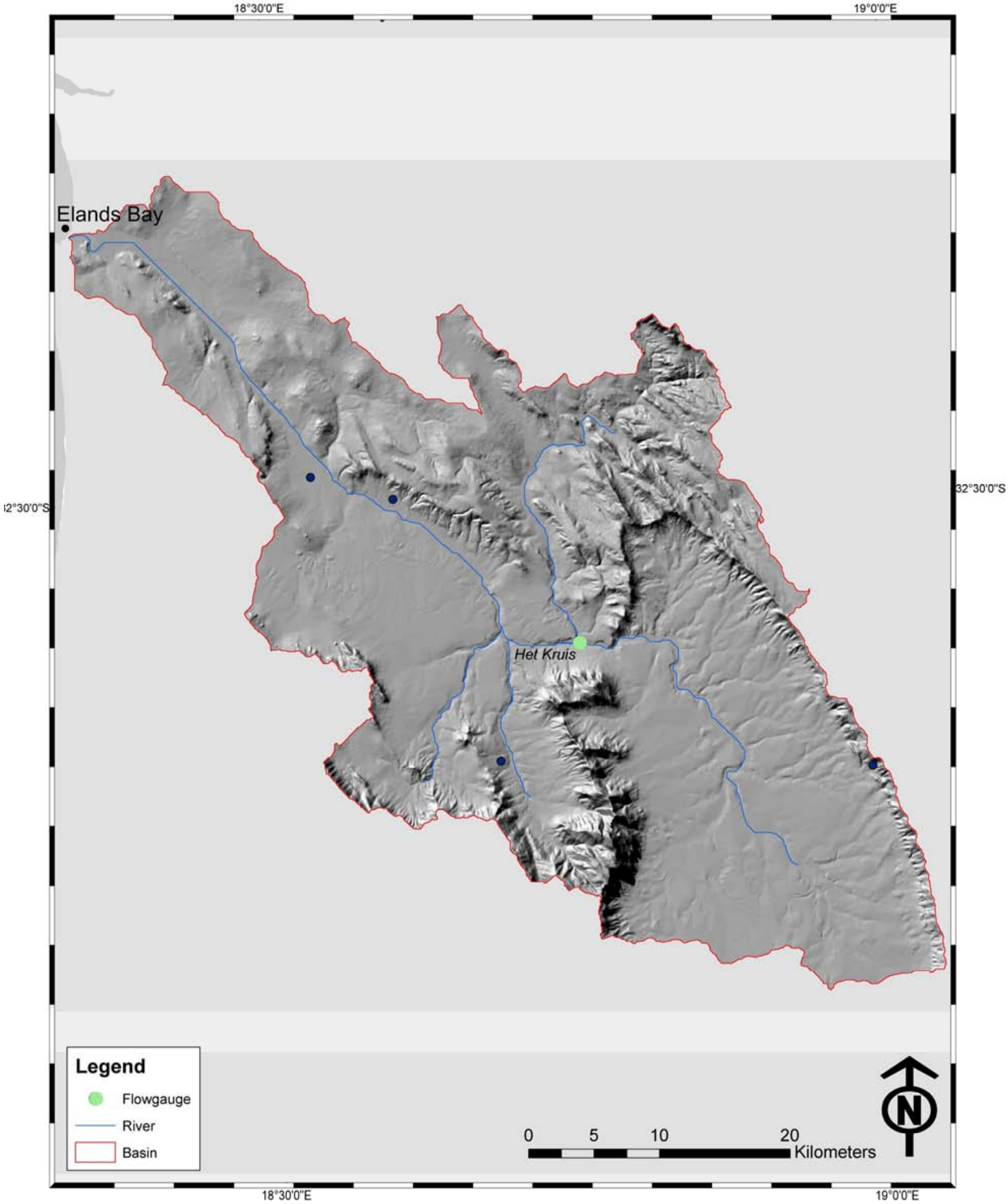


Figure 4.4 The position of the Verlorenvlei flow gauge within sub basin 5

4.3. FLOW RESULTS

The following graphs (Figure 4.5 and Figure 4.6) show precipitation records for the same time period as the comparative graph of flow results and measured flow.

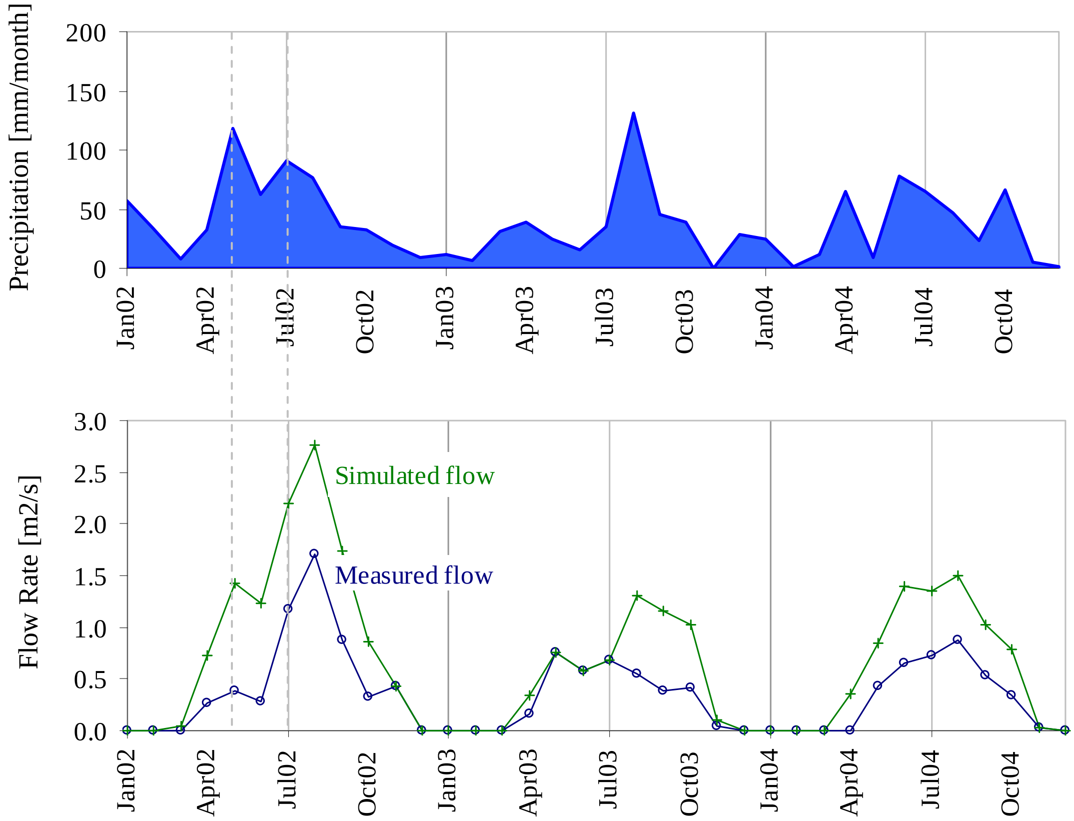


Figure 4.5 A comparison of rainfall, simulated and measured flow for sub basin 5 from January 2002 to October 2004

The simulated data result is based on the output.rch average monthly values for flow at the outlet to subbasin 5. The measured flow data was converted from daily flow to monthly average flow and data ranges from the final years of the simulation are depicted (January 2002 to October 2006). The volume of data makes it impractical to display the data for all 23 years.

Several interesting observations can be made from Figure 4.5 and Figure 4.6. Firstly, the precipitation data follows a more detailed and irregular pattern than that of the simulated and measured flow in the river, as one would expect from rainfall which is the initial hydrological input. Measured and simulated flows represent the hydrological process further down the chain of events where cumulative effects have caused water to flow in larger masses with slower response curves.

Secondly the rainfall peak for May2002 (along the left dotted grey line on Figure 4.5) is almost simultaneous with the flow measurements for the same time, however for June 2002 (along the right dotted grey line on Figure 4.5) the lag effect of accumulated rainfall is clearly depicted by the delayed steep rise in both measured and simulated flow. Simulated and measured flows follow very similar curves, although the simulated curve is consistently higher than the measured curve. This could be due to the fact that the model was not set up to take into account impoundments and water abstraction from the river.

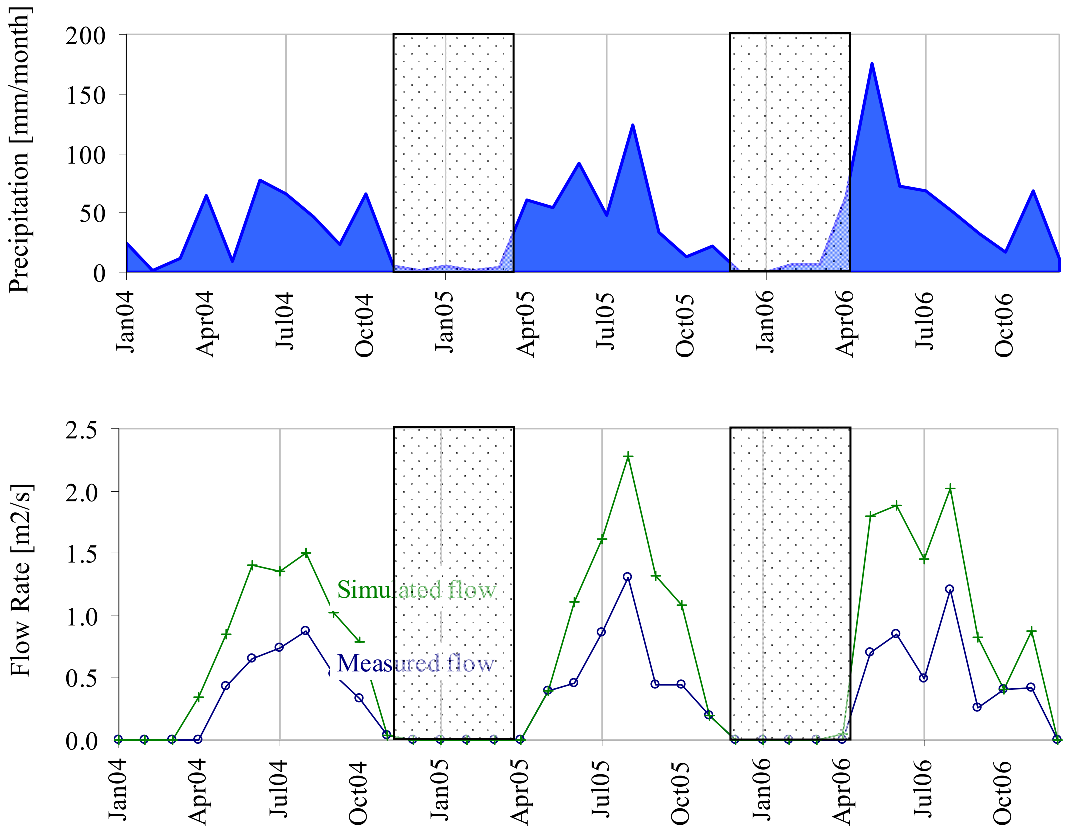


Figure 4.6 A comparison of rainfall, simulated and measured flow for sub basin 5 from January 2004 to October 2006

A third interesting phenomenon occurs between November 2004 and April 2005 as well as between December 2005 and April 2006 (see the dotted rectangles in Figure 4.6), similar periods of very low rainfall in the dry summer months. Both the simulated and the measured flow results concur on zero flow for those periods. What this could indicate is that the model is successfully simulating infiltration and storage losses.