5.3.5 Hydrogeological Potential Evaluation of Aquifers

The four above-mentioned indices were summed up at every 3Km^2 calculation grid in the basin for the synthetic evaluation of aquifers. The results are illustrated in Fig. 5.3-9 to 11.

1) Kalahari Aquifer

The southeastern part of the basin, which it is called the "Pre-Kalahari Valley" or "Salt Block", is evaluated badly. The area, which is given more than 275 points and evaluated as considerably good, extends widely in the western part of the basin. (Fig. 5.3-9)

2) Auob Aquifer

The central area of the western part of the basin including Stampriet obtains a good score of more than 300 points and as a result, it coincides with the present condition of high intensive withdrawal from this aquifer as shown in Fig.5.3-10. However, the area, which obtains less than 225 points, is distributed extensively in the southeastern part of the basin. It is remarkable that a considerable portion of the land in the north of Aminius reaches more than 250 points.

3) Nossob Aquifer

Most of the analyzed area is covered by a reddish color, which means less than 225 points and low or very low groundwater potential except for a small area around Stampriet. This aquifer is rarely utilized except for NAMWATER at Leonardville and Aranos as shown in Fig. 5.3-11.

On the basis of the evaluation results, it is possible to understand which aquifer has high potential in a certain area of the basin or which area of a certain aquifer is relatively better in terms of groundwater potential.

The synthetic evaluation for the three aquifers in the basin with four major indices is presented in this section. It is noticeable that this evaluation is not an absolute evaluation of each aquifer but a relative one. The results may vary depending on the purpose, statistic weight among indices, increase of hydrogeological data, progression of technology, and so forth.

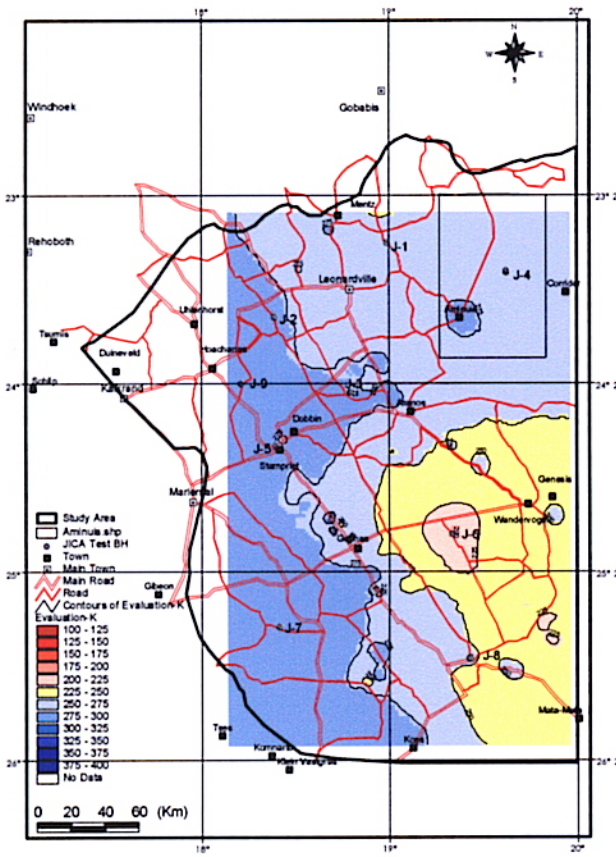

Fig. 5.3-9 Potential Evaluation of Kalahari Aquifer

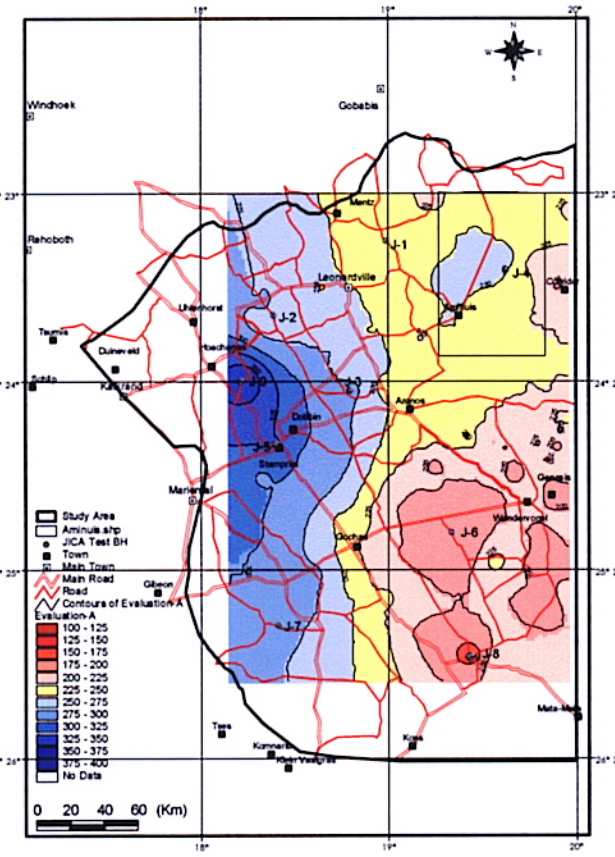

Fig. 5.3-10 Potential Evaluation of Auob Aquifer

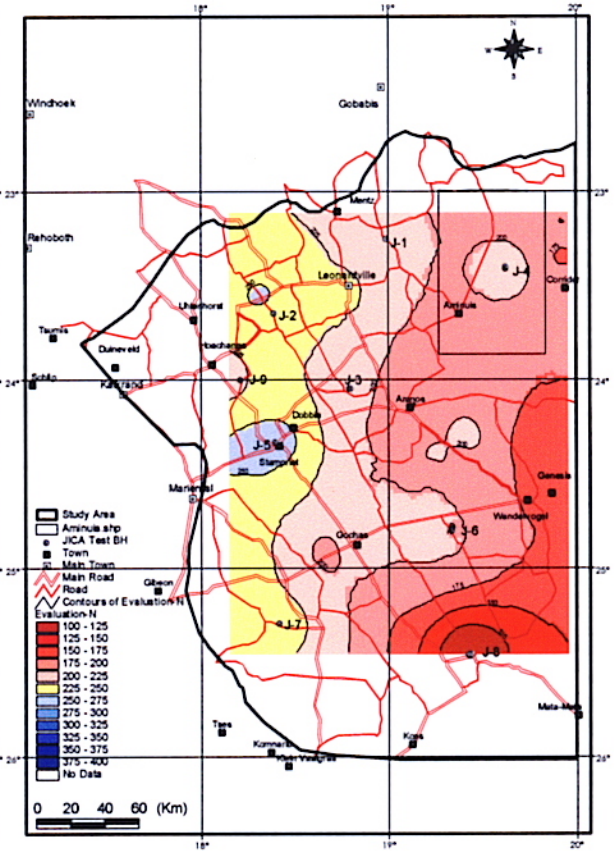

Fig. 5.3-11 Potential Evaluation of Nossob Aquifer

5.3.6 Groundwater Simulation

Additionally to the groundwater potential evaluation, a groundwater simulation was performed in order to evaluate it quantitatively.

1) Simulation Model

Based on hydro geological investigation, three aquifers (Kalahari, Auob and Nossob) in the Stampriet Artesian Basin were modelled using a finite difference three-dimensional model. The Kalahari Aquifer is unconfined, and the Auob and Nossob Aquifer are confined. The northern and southeastern boundaries are regarded as a constant head boundary to approximate groundwater inflow and outflow.

2) Input Data

The aquifer constants, groundwater abstraction, and recharge rates were inputted for each cell, manipulating from hydrological and hydrogeological studies. Present groundwater use in the basin amounts to 15 million m^3/year (domestic: 2.4 million m^3/year, stock watering: 5.7 million m^3/year, irrigation: 6.9 million m^3/year).

3) Calibration

Calculated heads were compared with results of the groundwater level survey. Then, these were calibrated with the variation of groundwater levels at observation wells. The calculated heads show a good agreement with the trend of observed groundwater levels.

4) Prediction

To predict the change of the groundwater level caused by the change of pumping rate, 6 cases were studied. Case 1 and 2 were assumed to maintain present groundwater use. In Case 3, the irrigation use was increased to 120% in comparison with the present use. In Cases 4 to 6, their irrigation uses were decreased to 70%, 50% and 0% respectively. The prediction period for each case is 100 years.

Table 5.3-2 Conditions of Groundwater Simulation Cases

Case	Pumping Rate (million m³/year)				Recharge Rate (million m³/year)	
	Domestic	Stock Watering	Irrigation (%)	Total (%)	Ordinary Year	1/50 Years Rainfall
1	2.36	5.69	6.89 (100)	14.94 (100)	4.60	-
2	2.36	5.69	6.89 (100)	14.94 (100)	4.60	79.86
3	2.36	5.69	8.27 (120)	16.32 (109)	4.60	79.86
4	2.36	5.69	4.82 (70)	12.87 (86)	4.60	79.86
5	2.36	5.69	3.44 (50)	11.49 (77)	4.60	79.86
6	2.36	5.69	0 (0)	8.05 (54)	4.60	79.86

5) Evaluation of Prediction Results

The results of the model simulation in the Stampriet Basin are summarized as Table 5.3-3 and some of the simulation results; Case 2, 4 and 5 are shown in Fig. 5.3-12 to 17.

Table 5.3-3 Results of Groundwater Simulation

Area	Stampriet Area				Other Area			
Constraint	Water Balance		Economic		Water Balance		Economic	
Aquifer / Case	Kalahari	Auob	Kalahari	Auob	Kalahari	Auob	Kalahari	Auob
1	NA	NA	UD	A	A	A/UD	G	G
2	NA	NA	UD	A	A	A	G	G
3	NA	NA	UD	UD	A	A	G	G
4	NA	UD	UD	G	A	A	G	G
5	UD	A	G	G	A	A	G	G
6	A/UD	A	G	G	A	A	G	G

Remarks: Water Balance, G=Good (0-0.03m/y), A=Allowable (0.03-0.10m/y), UD=Undesirable (>0.11m/y), NA=Not Allowable (Dry up)
(Drawdown) Economic: G=Good (0-10m), A=Allowable (10-20m), UD=Undesirable (>20m), NA=Not Allowable (Dry up)

6) Permissible Yield

The present groundwater abstraction (Case1, Case 2) is acceptable in the Stampriet Basin except for the Stampriet area. In the Stampriet area, the groundwater is mainly used for stock watering and domestic purposes. It is considered that groundwater use

will not increase remarkably. In the Tugela area, the declines of the groundwater level are slightly high with present groundwater pumpage. Careful monitoring is required.

In the Stampriet area, the Kalahari Aquifer will dry up in the near future, for example 25 years after in Case 3, if present groundwater abstraction is maintained. (refer to Fig. 5.3-18) From the above results, the pumping plan of Case 5 (reducing irrigation use to 50%) and Case 6 (reducing irrigation use to 0%) are acceptable in Stampriet area. Case 4 (reducing irrigation use to 70%) is not allowable since the Kalahari Aquifer will dry up within a period of 80 years. To prevent the dry-up of this aquifer, groundwater pumping for irrigation use has to be reduced to at least 50% of that in 1999, which is almost the same as the irrigation use in 1992.