Chapter 7

MULTIVARIATE LAND DEGRADATION ASSESSMENT

7.1 Introduction

A set of thirty one (31) variables, which define each of the 367 magisterial districts in South Africa in terms of biophysical environment and climate, land use and land tenure systems, demography, labour and employment and economic production indicators, have been outlined. Some of these variables have been described in previous chapters and are, therefore, only briefly discussed here. Next, in three correlation matrices, the study relates these variables to the set of land degradation indices (soil degradation, veld degradation index) which were developed during the workshops. Using these variables, the study developed several multiple regression models to identify the suite of biophysical and socio-economic factors. Three separate models are developed for soil degradation, veld degradation and the combined index of land degradation. In each case, the first relates all magisterial districts to the index of degradation, while the second and third models identify important variables for FAs and MAs separately.

7.2 The Data Set

Method

(a) The variables used in this analysis, are grouped into six broad categories (*i.e.* biophysical variables, climatic, landuse, demography, labour and employment and economic production). The abbreviation used, a brief description of each variable, and the unit of measurement, are shown in *Annex*. 2. The degradation indices and land use variables were derived from the workshops. All biophysical and climatic variables, except runoff and erodibility, were calculated from data sets available from the GIS directories of the Computing Centre for Water Research (CCWR), which are explained in detail in Schulze *et al.*, (1997). Runoff and erodibility were calculated from the Environmental Potential Atlas (ENPAT, 1996) database (van Riet *et al.*, 1997). The mean values for each of 367 magisterial district were calculated using the ArcView GIS™. Demography, labour and employment, and economic production variables were taken from the nine statistical macro-economic reviews (one for each province) published by the Development Bank of Southern Africa in 1995.

(b) The soil **degradation index (SDI)** and **vegetation degradation index (VDI)** were added up to form a **combined degradation index (CDI)** of land degradation in South Africa. The SDI and VDI values are shown in *Table 7.1.*

Table 7.1: The mean values for each province and for favoured and marginal areas for the soil degradation index (SDI), veld degradation index (VDI) and combined index degradation (SDI =VDI) (N=367). The information is based on the perceptions of the agricultural personnel gathered during a series of workshops.

Province	**Number of magisterial district**	**Mean values for degradation index**		
		SDI	**VDI**	**SDI +VDI**
Eastern Cape	78	200	116	316
Free State	51	48	86	134
Gauteng	22	113	31	143
KwaZulu Natal	51	253	187	440
Mpumalanga	30	143	81	223
Northern Cape	26	92	140	232
Northern Province	39	255	189	444
NorthWest	28	149	122	270
Western Cape	42	77	93	170
Favoured districts	**262**	**102**	**96**	**198**
Marginal districts	**105**	**292**	**183**	**475**

c) The final analysis comprised a total of 348 magisterial districts. Seventeen highly urbanised districts in Gauteng, KwaZulu Natal and Western Cape, with 50% settlement and the two districts comprising the Kruger National Park (Soutpansberg and Pilgrim's Rest) were discarded.

7.3 RESULTS AND DISCUSSION

7.3.1 Correlation matrices

7.3.1.1 Full Data Set

Spearmans Rank correlation values between the degradation indices, land use, the biophysical and socio economic variables for the 348 magisterial districts used in the final analysis are shown in *Table 7.6*. Soil degradation and veld degradation indices are strongly related to each other and, in general, when a district contains high levels of soil degradation, high levels of veld degradation are also perceived to be present. Since the combined index of degradation is comprised of the sum of the soil and veld degradation indices, it is not surprising that it should be highly significantly correlated with both of these indices.

While the **soil degradation index (SDI)** is significantly correlated ($p<0.5$) with all but four of the 31 variables, it is most strongly related to the land tenure system, which defines the district *(Table 7.6)*. In fact, more than 50% of the variance in the soil degradation index can be explained simply by knowing the percentage area of a district that is managed under a favoured or a marginal land tenure system *(Table 7.6)*. Soil degradation is also strongly related to a suite of variables, which differentiate so clearly the favoured and marginal areas. For example, soil degradation appears most strongly correlated with the human, animal and settlement density which characterises the rural areas, where unemployment and poverty are prevalent and where a higher proportion of the economically active population, especially the males, are absent from the region. However, biophysical and climatic variables should not be ignored and the location of marginal areas generally with steeper slopes, less summer aridity, but with greater annual temperatures, should also be noted.

Compared with the soil degradation index, the **veld degradation index (VDI)** appears less significantly correlated with the variables shown in *Table 7.6*. It is also less significantly correlated with the land tenure system of the district, although many of the same variables emerge as significant correlates of both soil and veld degradation. The biophysical and climatic variables which are most strongly related to veld degradation are again slope and temperature while the percentage of a district used for grazing lands and stocking density are also positively related to veld degradation.

When the soil and veld degradation indices are **combined** into a single index, the strong correlation with the land tenure system is again evident *(Table 7.6)*. Slope and temperature remain the most significant biophysical and climatic correlates, while a very similar set of socio-economic parameters, that is related to soil degradation, also appears related to the combined index of degradation.

7.3.1.2 Favoured Areas (FA)

Although significantly correlated ($p<0.05$), the soil degradation and veld degradation indices are relatively weakly related in the 226 **FA**, *(Table 7.8)*. (In this analysis a magisterial district was classified as a favoured area if more than 80% of its area was managed under a large-scale land tenure system*)*. This suggests that areas, which are perceived to have relatively high levels of soil degradation, do not necessarily exhibit high levels of veld degradation in the FA. It is significant that only one of the socio-economic variables is correlated with the **SDI** in the favoured areas *(Table 7.7)*. Several variables, however, which describe the biophysical and climatic environment, together with a few land use factors, are significantly related to soil degradation. Large favoured magisterial districts which are at low altitudes and which possess steep slopes with infertile soils, possess significantly higher levels of soil degradation than others. Districts with high mean annual temperatures and more growing days are also more degraded. Soil degradation also appears negatively related to stocking density in the FA. Select magisterial districts in KwaZulu Natal (e.g. Weenen, Glencoe, and Kliprivier), in the upper reaches of the Sundays River Valley in the Eastern Cape (e.g. Aberdeen, Jansenville, Pearston, Graaff-Reinet), close to the Orange River in the west (e.g. Prieska, Britstown, Gordonia) and in the Little Karoo (e.g. Montagu, Oudtshoorn, Calitzdorp) have the highest index of soil degradation amongst the favoured magisterial districts.

The **VDI** in the FA is negatively related to altitude and positively related to temperature and the ratio of mean annual precipitation to evapotranspiration potential *(Table 7.7)*. It is also significantly related to districts, which are dominated by grazing lands with a low settlement area. Stocking density is not related to the veld degradation index. Favoured magisterial districts with high annual growth in the agricultural sector and the GGP in general, possess higher levels of veld degradation. Unlike for soil degradation, the top 10 favoured magisterial districts with the highest veld degradation indices are widely scattered throughout the country (i.e. Weenen, Marico, Britstown, Komga, Boshof, Koffiefontein, Messina, Oudtshoorn, Fraserburg and Hay).

The **CDI** in favoured areas is significantly correlated with low altitude, large district size, steep slope, low soil fertility and high mean annual temperatures *(Table 7.7)*. Favoured districts with large areas of grazing lands and low stocks densities, relatively smaller cropland area and settlements possess a higher combined index of degradation. Low population density, with a high proportion of people employed in the agricultural sector and an actively growing economy, is also a significant correlate.

7.3.1.3 Marginal Areas (MA)

Eighty-nine magisterial districts, (in which more than 80% of the area was managed under a marginal land tenure system), were used in this analysis *(Table 7.8)*. Of the three data sets (full data set, favoured districts only and marginal districts only), soil and veld degradation indices are the most closely related in the marginal areas. Marginal districts, which have a high soil degradation index, tend to also possess a high veld degradation index. **Soil degradation** in marginal areas was significantly correlated ($p<0.05$) with only four variables *(Table 7.8)*. These were high altitudes, steep slopes, a proportionately higher area of grazing lands in the district and high levels of poverty as expressed in the GGP per capita ratio. Magisterial districts with relatively high soil degradation indices were in the higher lying areas of the Eastern Cape (e.g. Herschel, Qumbu Mount Fletcher, Engcobo), KwaZulu Natal (e.g. Nquthu, Msinga, Nongoma, Nkandla) and the Northern Province (Naphuno 2, Mankweng, Schoonoord, Sekgosese 1).

The **VDI** was significantly correlated with nearly half of the variables used in this analysis *(Table 7.8)*. Districts with low mean annual rainfall and relatively high summer aridity and low runoff amounts generally showed higher levels of veld degradation than others. Land use appears a particularly important influence on veld degradation. The VDI was correlated with 5 of the eight land use variables, although land use variables were also frequently co-correlated. Marginal magisterial districts with relatively large areas of veld and conservation or state lands, small areas of cropland, small favoured forest areas and small settlements areas generally had higher levels of veld degradation. Finally, districts, which had higher levels of unemployed men, particularly within a formal agricultural sector that was not growing (although GGP growth itself was high), also showed higher levels of veld degradation. Magisterial districts in the Northern Province (Mutual, Praktiseer, and Schoonoord), KwaZulu Natal (Nkandla, Pholela, Mahlabathini, Nongoma, and Nquthu) and the Northwest Province (Lehurutshe, Madikwe) were among the worst ten marginal districts in terms of veld degradation.

None of the five climatic variables and none of the four demographic variables were significantly correlated with the **combined index** of soil and veld degradation *(Table 7.8)*. High altitude areas with steep slopes, small area of croplands and favoured forests and large areas of grazing lands had higher combined degradation values index values. Marginal area magisterial districts with a high level of unemployment and with a low percentage of people employed in a formal agricultural sector that showed low annual growth, generally possessed higher CDI values. High levels of poverty, as shown by the GGP per capita index, were also correlated with the combined degradation index value. Six KwaZulu Natal districts (Nkandla, Nquthu, Nongoma, Pholela, Mahlabathini and Msinga), three Northern Province districts (Mutale, Schoonoord and Praktiseer) and one Eastern Cape district (Herschel) comprise the top ten districts in terms of combined degradation index values.

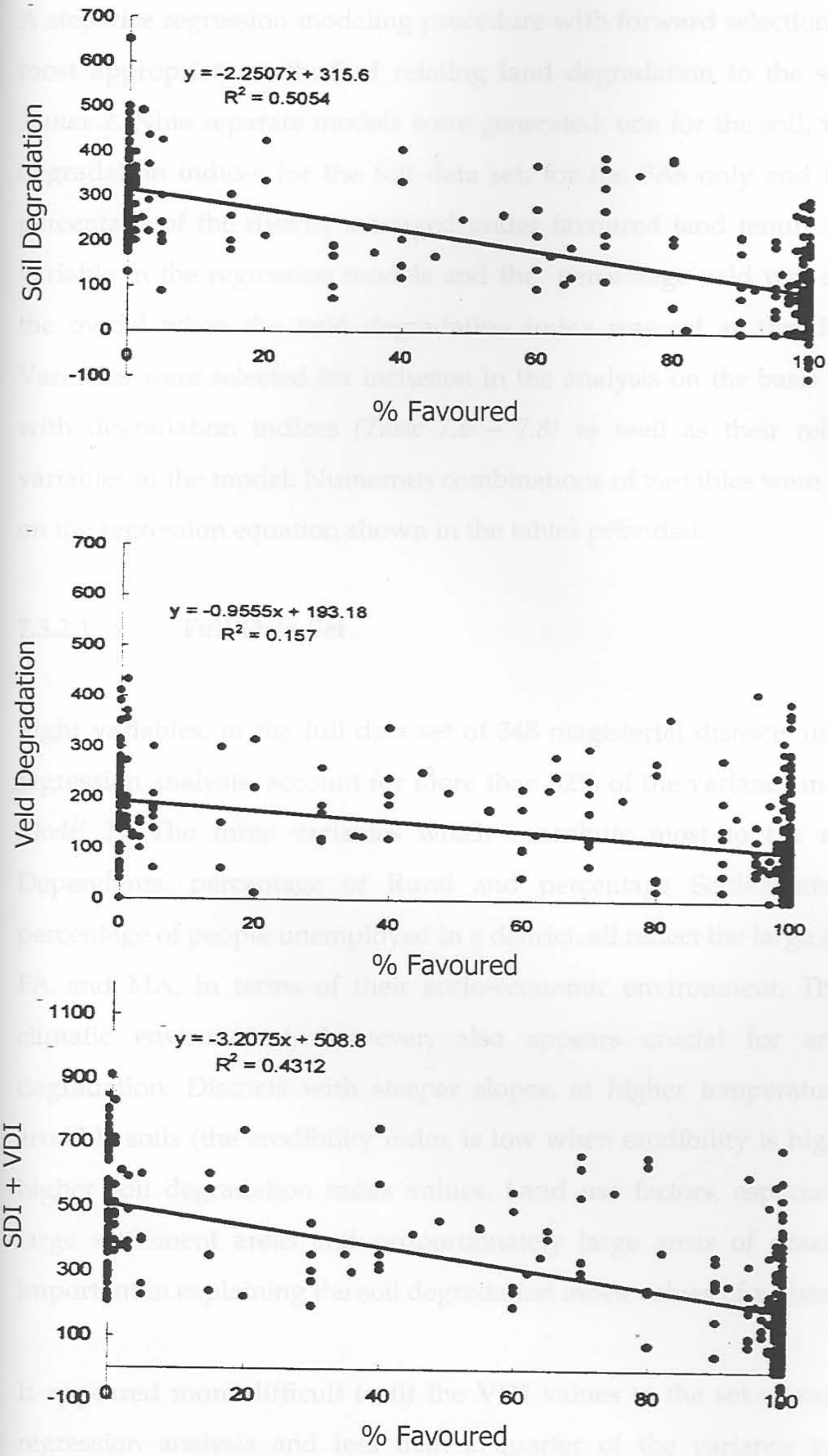

Figure 7.1 Relationship between the % of a district managed under a favoured land tenure system and three indices of degradation. $p<0.001$ in all cases

7.3.2. Predicting Land Degradation

A stepwise regression modeling procedure with forward selection was chosen as the most appropriate method of relating land degradation to the suite of variable in *Annex 2*. Nine separate models were generated: one for the soil, veld and combined degradation indices for the full data set, for the FAs only and for MAs only. The percentage of the district managed under favoured land tenure was excluded as a variable in the regression models and the percentage veld was also excluded from the model when the veld degradation index was set as the dependent variable. Variables were selected for inclusion in the analysis on the basis of their correlation with degradation indices *(Table 7.6 – 7.8)* as well as their relationship to other variables in the model. Numerous combinations of variables were tried before setting on the regression equation shown in the tables provided.

7.3.2.1 Full Data Set

Eight variables, in the full data set of 348 magisterial districts used in the stepwise regression analysis, account for more than 52% of the variance in the **SDI** *(Table 7.2, Model 1)*. The three variables which contribute most to the model (number of Dependents, percentage of Rural and percentage Settlements) as well as the percentage of people unemployed in a district, all reflect the large distinction between FA and MA, in terms of their socio-economic environment. The biophysical and climatic environment, however, also appears crucial for any model of soil degradation. Districts with steeper slopes, at higher temperature and with more erodible soils (the erodibility index is low when erodibility is high *(Annex 2)* posses higher soil degradation index values. Land use factors, especially proportionately large settlement areas and proportionately large areas of grazing lands are also important in explaining the soil degradation index values of a district.

It appeared more difficult to fit the **VDI** values to the set of variables used in the regression analysis and less than a quarter of the variance is explained in the regression model in *Table 7.2 (Model 2)*. Biophysical and climatic factors appeared the most important predictors of veld degradation, with the percentage of people unemployed in a magisterial district, the only significant socio-economic variable selected in the regression equation. Districts with steep slopes, high mean annual temperatures, yet low MAP:PET ratios and high levels of unemployment also possess high veld degradation index values. For the **CDI** *(Model 3)* many of the same variables already mentioned were included in the model. Stocking rate, however, is included for the first time, although it accounts for only a small fraction of the variance in the data. A mixture of socio-economic, biophysical, climatic and land use factors all appear important in accounting for nearly half of the variance in the combined degradation index data set.

7.3.2.2 Favoured Areas (FA)

The three regression models for **soil, veld** and the **CDI** *(Table 7.3. Model 4-6)* are different from those for the full data set and the marginal areas in two important ways. First, they account for far less of the variance in the data than the others with only 15%, 9% and 28% of the variance in the soil, veld and combined index values being explained in the respective models. Secondly, biophysical and climatic variables (especially mean annual temperature and slope), are the most significant factors to account for degradation in the favoured districts. Land use factors, such as a high proportion of grazing lands or veld in the district, as well as stocking rates, also appear significant for the combined degradation index. However, no demographic, labour and employment or economic production factors contributed significantly to any of the three-degradation model in the FA.

7.3.2.3 Marginal Areas (MA)

Although less than 20% of the variance is explained in the model *(Table 7.4, Model 7)* **soil degradation** in MA appears greater on steeper slopes in low rainfall areas. The significant contribution to soil degradation of the biophysical and climatic environment should, therefore, not be underestimated in MA. The **VDI** *(Model 8)* is best explained by low rainfall, steep slopes, a higher number of grow days, fertile soils and a high degree of poverty. This suggests that very poor MA in which people are possibly more reliant on the grazing areas to augment their livelihoods, are more prone to veld degradation than others. The steeply sloping, sweetveld areas, which generally possess lower rainfall and more fertile soil, are particularly susceptible. The final model *(Model 9)* for the **CDI** suggests that the absence of a formal agricultural sector may also be an important predictor of land degradation in the marginal areas. Other than this difference the model is very similar to that for veld degradation although it explains close to half of the variance in the data for 89 MA.

Regression model summary

Table 7.5 summarizes the results of the nine regression models outlined earlier. It shows which variables are consistently the most important predictors of land degradation for the full data set and independently for districts managed under favoured or marginal land tenure systems. It is clear that the biophysical climatic environments are both important predictors of land degradation, irrespective of land tenure system. Slope appears the most important variable while mean annual temperature is significant in the full data set and when favoured areas are considered separately. Low mean annual rainfall replaces temperature as the most important climatic factor when marginal areas are analyzed. Erodibility, fertility, MAP: PET and the number of grow days were important but inconsistent in their value as significant predictive variables of land degradation. Of the land use variables, only the proportional contribution of grazing lands and settlements appeared important, while the stocking rate contributed a little, and only in two of the combined degradation index models.

The only demographic variable to contribute significantly to any of the models was the percentage of the population living in a rural environment. This variable, together with the number of dependents and the GGP per capita ratio, distinguishes the marginal and favoured areas. It does not necessarily mean that, because none of the other demographic factors were included as significant variables in any of the models, they are not important in land degradation issues. The previous chapter has examined the role of population density and the absence of labour on land degradation. In this analysis, however, they appeared poor predictors of land degradation, population density and the absence of labour. Three indices, all linked to issues of poverty, emerged fairly frequently, and often very significantly, as contributors to the degradation models. The percentage of people unemployed, the number of dependents and GGP per capita ratio all appeared important and often in very different combinations of factors. The role of poverty, and the subsequent reliance on natural resources as a "safety net", is poorly understood and written about in the land degradation literature. The way in which poverty translates into direct impacts on the natural environment, is not well known. Finally, the single contribution of the number of people employed in the formal agricultural sector as a significant factor in one of the models, suggests that the formal agricultural sector may have an important role to play in influencing the severity and rate of land degradation, even within the marginal areas.

Table 7.2: Results from stepwise regression models which relate biophysical, climatic and socio-economic variables to soil degradation, veld degradation and a combined index of degradation for 348 favoured and marginal magisterial districts in South Africa. The t-statistic for all variables in the model is significant at p<0.05

Soil Degradation Index (SDI)(MODEL 1)				
Variable	**Coefficient**	**Std Error**	**t-statistic**	**R-squared**
Constant	**-250.2950**			
#DEPENDENTS	7.3987	2.9768	2.4855	0.3258
%RURAL	1.0380	0.2434	4.2648	0.3874
%SETTLEMENTS	2.4123	0.5898	4.0903	0.4188
SLOPE	31.2002	5.4574	5.7170	0.4519
TMEAN	14.2129	2.9980	4.7408	0.4845
%VELD	0.5262	0.2568	2.0485	0.5053
%UNEMPLOYED	1.4861	0.5586	2.6602	0.5154
ERODIBILITY	-4.0821	1.5406	-2. 6496	0.5252

Veld Degradation Index (VDI) (MODEL 2)				
Variable	**Coefficient**	**Std Error**	**t-statistic**	**R-squared**
Constant	**-129.2789**			
TMEAN	**18.1592**	**2.7304**	**6.6507**	**0.1044**
SLOPE	37.6698	6.9974	5.3834	0.1681
%UNEMPLOYED	1. 6268	0.4115	3.9532	0.2091
MAP:PET	-116.2645	42.0193	-2.7669	0.2264

Combined Degradation Index (VDI) (MODEL 3)				
Variable	**Coefficient**	**Std Error**	**t-statistic**	**R-squared**
Constant	-683.1599			
%RURAL	1.5100	0.35777	4.2214	0.2601
%UNEMPLOYED	3.6257	0.7809	4.6432	0.3418
SLOPE	59. 0938	8.5719	6.8939	0.3864
TMEAN	33. 7084	4.8292	6.9801	0.4404
%VELD	1.7880	0.3404	5.2521	0.4714
LSU/HA	177.4147	57.7479	3.0722	0.4856

Table 7.3: Results from stepwise regression models which relate biophysical, climatic and socio-economic variables to soil degradation, veld degradation and a combined index of degradation for 226 magisterial districts in South Africa which have more 80% of their surface area managed under a FAVOURED land tenure system. The t-statistic for all variables in the model is significant at $p<0.05$

Variable	Coefficient	Std Error	t-statistic	R-squared
Soil Degradation Index (SDI)(MODEL 4)				
Constant	-211.5759			
SLOPE	16.2044	5.8673	2.7618	0.1502
TMEAN	20.5466	3.8017	5.4046	0.0715
ERODIBILITY	-4.8561	1.5273	-3. 1795	0.1210
Veld Degradation Index (VDI) (MODEL 5)				
Constant	-129.6238			
TMEAN	18.2396	4.0242	4.5325	0.0751
SLOPE	12.6522	6.3734	1.9851	0.0912
Combined Degradation Index (VDI) (MODEL 6)				
Constant	-804.4170			
SLOPE	38. 5714	9.2623	4.1643	0.2565
TMEAN	46. 4866	6.2802	7.4021	0.1101
%VELD	2.1074	0.3301	6.3833	0.2162
LSU/HA	271.3085	91.7193	2.9580	0.2848

Table 7.4: Results from stepwise regression models which relate biophysical, climatic and socio-economic variables to soil degradation, veld degradation and a combined index of degradation for 89 magisterial districts in South Africa which more than 80% of their surface area managed under MARGINAL. The t-statistic for all variables in the model is significant at p<0.05

Soil Degradation Index (SDI)(MODEL 7)

Variable	Coefficient	Std Error	t-statistic	R-squared
Constant	363.0127			
SLOPE	62.8009	13.8232	4.5431	0.1081
MAR	-0.2398	0.0794	-3. 0185	0.1935

Veld Degradation Index (VDI) (MODEL 8)

Variable	Coefficient	Std Error	t-statistic	R-squared
Constant	177.6677			
MAR	-0.4105	0.0666	-6.1649	0.1736
SLOPE	59.0663	12.0574	4.8988	0.2895
#GROWDAYS	2. 0049	0.5495	3.6487	0.3227
FERTILITY	20.8928	6.29344	3.3198	0.3648
GP/CAP	-0.0271	0.0137	-1.9830	0.3769

Combined Degradation Index (VDI) (MODEL 9)

Variable	Coefficient	Std Error	t-statistic	R-squared
Constant	-683.1599			
AGREMPLOYED	-2.9309	1.3518	-2.1682	0.1001
GGP/CAP	-0.0791	0.0257	-3.1493	0.2094
SLOPE	59. 0938	8.5719	6.8939	0.3864
MAR	-0. 5611	0.1363	-4.1177	0.3434
FERTILITY	41.3966	10.9421	3.7832	0.4189
#GROWDAYS	2.2551	1.0992	2.0516	0.4472

*Table 7.5. The percentage contribution of biophysical, climatic and socio-economic variables to the total R^2 value for each of nine stepwise regression models developed to explain the levels of soil degradation, veld degradation and a combined index of soil plus veld degradation in all the magisterial districts of South Africa (n=348) (minus the highly-urbanised districts), in favoured districts (>80% favoured (n=226)), and in marginal districts (>80%marginal (n=89)). The total R^2 value (*100) for each model is also shown. Negative values indicate the variable was negatively related to the related to the dependent factor.*

Variable	All districts			Favoured (>80%)			Marginal (>80%)		
	SDI	VDI	SDI+VDI	SDI	VDI	SDI+VDI	SDI	VDI	SDI+VDI
Biophysical									
AREA									
ALT									
SLOPE	6	28	9	19	18	14	56	29	14
RUNOFF									
ERODE	(-) 2			(-) 33					
FERTIL								11	17
Climatic MAR							(-)44	(-)44	(-)16
SAI									
MAP: PET		(-) 8							
GROWDAYS								8	
TMEAN	6	46	11	48	82	39			
Landuse %CROPS									
%VELD									
%FOREST	4		6			37			
%CON									
%SET									
%OTH	6								
LSU/HA			3			10			
Demography %MALE									
%15-64									
%RURAL									
Labour & Employment %UNEMPLOY	12		54						
AGREMPLOY									
LABGROWTH									
#DEPEND	2	18	17						(-)22
Economic production GGP/CAP									
AGRTOGGP									
AGROWTH	62								
GGGPGROW								(-) 8	(-)24
Total %	100	100	100	100	100	100	100	100	100
Total $R^2 \cdot 100$	52.2	22.6	48.6	15.0	9.1	28.5	19.4	37.7	44.7
Model #	1	2	3	4	5	6	7	8	9

Table 7.6 Spearmans Rank correlations of degradation indices with biophysical, climatic, landuse, demographic, labour and employment and economic production variables. Degrees of freedom are 348 and for significance levels of p<0.05; 0.01 and 0.001, r-0.105 0.137 and 0.175 respectively

Degradation Indices																																		
SDI	SDI																																	
VDI	0 472	VDI																																
SDI+VDI	0 869	0 828	SDI+VDI																															
Biophysical variables																																		
AREA	-0 178	-0 005	-0 097	AREA																														
ALT	-0 256	-0 260	-0 333	0 134	ALT																													
SLOPE	0 321	0 245	0 0 337	0 134	0 246	SLOPE																												
RUNOFF	0 190	0 118	0 178	0 362	0 257	0 597	RUNOF																											
ERODE	-0 263	-0 133	-0 254	0 038	0 082	0 342	0 157	ERODE																										
EFERTIL	-0 106	-0 006	-0 067	0 182	0 286	0 280	0 216	0 286	FERTIL																									
Climatic variables																																		
MAR	0 279	0 096	0 204	0 462	0 000	0 474	0 797	0 041	0 160	MAR																								
SAI	-0 342	0 080	0 229	0 313	0 318	0 237	0 533	0 058	0 040	0 837	SAI																							
MAP:PET	0 314	0 226	0 318	0 358	0 375	0 679	0 808	0 127	0 224	0 748	0 430	MAP:PET																						
GROWDAYS	0 338	0 148	0 272	0 236	0 023	0 201	0 063	0 039	0 023	0 397	0 618	0 096	GRWODAYS																					
TMEAN	0 401	0 340	0 448	0 076	0 692	0 108	0 015	0 064	0 150	0 029	0 025	0 126	0 543	TIMEAN																				
Land use																																		
MERCIAL	0 649	0 472	0 654	0 262	0 319	0 271	0 322	0 214	0 045	0 371	0 373	0 395	0 344	0 465	MERCIAL																			
%CROPS	0 023	0 109	0 087	0 202	0 030	0 050	0 260	0 161	0 046	0 323	0 168	0 234	0 135	0 033	0 205	%CROPS																		
%VELD	0 061	0 267	0 124	0 531	0 137	0 032	0 365	0 286	0 235	0 438	0 310	0 334	0 275	0 128	0 205	0 607	%VELD																	
%FOR	0 217	0 134	0 211	0 135	0 232	0 541	0 650	0 034	0 184	0 612	0 387	0 604	0 055	0 029	0 338	0 138	0 206	%FOR																
%CON	0 005	0 033	0 008	0 192	0 157	0 043	0 025	0 151	0 090	0 047	0 097	0 089	0 002	0 132	0 007	0 015	0 014	0 027	%CON															
%SET	0 406	0 086	0 275	0 635	0 143	0 049	0 293	0 053	0 206	0 467	0 426	0 323	0 431	0 260	0 529	0 213	0 648	0 151	0 091	%SET														
%OTH	0 149	0 156	0 208	0 060	0 212	0 270	0 149	0 393	0 047	0 052	0 135	0 140	0 260	0 019	0 161	0 132	0 629	0 181	0 023	0 167	%OTH													
LSU/HA	0 310	0 230	0 299	0 311	0 118	0 150	0 434	0 191	0 188	0 525	0 535	0 357	0 255	0 018	0 528	0 149	0 228	0 302	0 119	0 390	0 132	LSU/HA												
Demographic																																		
%UNEMPL	0 314	0 094	0 219	0 753	0 209	0 090	0 386	0 114	0 228	0 559	0 428	0 426	0 446	0 283	0 468	0 282	0 656	0 173	0 079	0 816	0 194	0 414	POPDEN											
%MALE	0 492	0 253	0 450	0 165	0 165	0 253	0 117	0 444	0 122	0 088	0 061	0 174	0 013	0 117	0 525	0 002	0 045	0 080	0 114	0 285	0 383	0 399	0 196	%MALE										
%15-64	0 450	0 249	0 425	0 008	0 012	0 129	0 033	0 407	0 218	0 021	0 112	0 054	0 038	0 084	0 516	0 031	0 177	0 041	0 171	0 118	0 389	0 454	0 008	0 846	%15-64									
%RURAL	0 529	0 378	0 535	0 0003	0 089	0 215	0 239	0 212	0 080	0 294	0 400	0 276	0 353	0 373	0 670	0 209	0 062	0 281	0 033	1 238	0 195	0 491	0 099	0 498	0 653	%RURAL								
Labour& employment																																		
%UNEMPL	0 375	0 233	0 361	0 238	0 037	0 006	0 031	0 258	0 145	0 084	0 154	0 011	0 225	0 185	0 489	0 103	0 041	0 092	0 150	0 340	0 183	0 385	0 359	0 359	0 660	0 620	0 294	%UNEMPL							
AGREMPL	0 162	0 074	0 116	0 475	0 099	0 121	0 001	0 096	0 119	0 127	0 092	0 058	0 265	0 163	0 242	0 068	0 300	0 168	0 035	0 579	0 276	0 109	0 697	0 697	0 070	0 150	0 247	0 392	AGREMPL						
LABAGROW	0 086	0 043	0 069	0 147	0 055	0 033	0 048	0 035	0 003	0 007	0 013	0 021	0 163	0 116	0 096	0 020	0 021	0 0221	0 062	0 118	0 066	0 013	0 172	0 172	0 124	0 075	0 007	0 295	0 331	LABAGROW					
#DEPEND	0 471	0 290	0 463	0 059	0 060	0 161	0 092	0 417	0 185	0 076	0 135	0 002	0 085	0 123	0 562	0 047	0 142	0 069	0 172	0 165	0 394	0 503	0 089	0 089	0 836	0 943	0 618	0 699	0 049	0 115	#DEPEND				
Economic production																																		
GGP/CAP	0 496	0 312	0 485	0 197	0 138	0 168	0 130	0 324	0 132	0 154	0 195	0 174	0 204	0 255	0 610	0 093	0 008	0 082	0 136	0 267	0 332	0 458	0 221	0 221	0 737	0 826	0 666	0 692	0 010	0 140	0 856	GGP/CAP			
AGRTOGP	0 206	0 076	0 145	0 442	0 126	0 071	0 034	0 129	0 153	0 214	0 186	0 123	0 316	0 238	0 260	0 019	0 351	0 035	0 027	0 595	0 316	0 110	0 707	0 707	0 019	0 200	0 181	0 244	0 857	0 204	0 125	0 116	AGRTOGGP		
AGROWTH	0 213	0 267	0 278	0 023	0 155	0 245	0 154	0 096	0 202	0 046	0 010	0 170	0 029	0 129	0 238	0 080	0 084	0 180	0 043	0 084	0 200	0 002	0 044	0 044	0 174	0 123	0 222	0 053	0 007	0 182	0 134	0 095	0 139	AGROWTH	
GGGROW	0 405	0 387	0 458	0 116	0 244	0 228	0 200	0 162	0 154	0 147	0 138	0 255	0 189	0 321	0 456	0 066	0 001	0 144	0 052	0 282	0 149	0 149	0 248	0 248	0 321	0 251	0 394	0 235	0 206	0 031	0 263	0 261	0 141	0 645	

Table 7.7 Spearmans rank correlations of degradation indices with biophysical climatic, land use demographic labour and employment and economic production variables for magisterial districts which have 80% or more of their land surface managed under favoured land tenure systems. Degrees of freedom are 244 and for significance levels of p<05 0 01 and 0 001 r= 0124 0 162 and 0 206 respectively

Degradation Indices
SDI	SDI
VDI	0 144	VDI
SDI+VDI	0 714	0 729	SDI+VDI
Biophysical variables
AREA	0 125	0 145	0 207	AREA
ALT	0 158	0 230	0 321	0 088	ALT
SLOPE	0 167	0 144	0 237	0 077	0 279	SLOPE
RUNOFF	0 055	0 037	0 031	0 410	0 075	0 510
ERODE	0 040	-0 003	0 091	0 162	0 017	0 358	ERODE
FERTIL	-0 184	-0 006	0 105	0 162	0 342	0 366	0 308	FERTIL
Climatic variables
MAR	0 046	0 037	0 069	0 514	0 312	0 283	0 163	0 214	MAR
SAI	0 128	0 078	0 037	0 272	0 638	0 055	0 081	0 083	0 771	SAI
MAP:PET	0 095	0 154	0 147	0 337	0 217	0 0627	0 028	0 308	0 663	0 224	MAP:PET
GROWDAYS	0 198	0 025	0 074	0 118	0 347	0 386	0 131	0 194	0 382	0 722	0 099	GRWODAYS
TMEAN	0 254	0 222	0 340	0 167	0 677	0 142	0 257	0 156	0 186	0 176	0 042	0 284	TIMEAN
Land use
MERCIAL	0 082	0 025	0 170	0 055	0 148	0 143	0 071	0 032	0 151	0 127	0 238	0 079	0 219	MERCIAL
%CROPS	0 132	0 034	0 177	0 226	0 061	0 118	0 243	0 015	0 278	0 148	0 298	0 136	0 022	0 254	%CROPS
%VELD	0 058	0 259	0 289	0 556	0 010	0 118	0 464	0 301	0 503	0 268	0 370	0 260	0 093	0 112	0 621	%VELD
%FOR	0 087	0 088	0 103	0 096	0 171	0 520	0 121	0 381	0 522	0 212	0 601	0 131	0 023	0 309	0 130	0 191	%FOR
%CON	0 136	0 058	0 101	0 101	0 210	0 146	0 073	0 120	0 019	0 047	0 229	0 056	0 182	0 208	0 093	0 124	0 146	%CON
%SET	0 003	0 190	0 211	0 552	0 155	0 121	0 355	0 275	0 530	0 369	0 068	0 341	0 051	0 091	0 33	0 691	0 072	0 008	%SET
%OTH	0 015	0 110	0 136	0 209	0 203	0 277	0 422	0 52	0 269	0 327	0 199	0 404	0 106	0 017	0 215	0 413	0 022	0 025	0 443	%OTH
LSU/HA	0 143	0 016	0 141	0 286	0 478	0 132	0 006	0 259	0 472	0 499	0 231	0 234	0 339	0 157	0 417	0 0221	0 095	0 067	0 225	0 092	LSU/HA
Demographic
%UNEMPL	0 057	0 098	0 171	0 727	0 041	0 007	0 386	0 267	0 660	0 405	0 442	0 330	0 032	0 138	0 397	0 756	0 202	0 028	0 728	0 411	0 347	POPDEN
%MALE	0 028	0 065	0 036	0 039	0 028	0 150	0 432	0 181	0 222	0 281	0 060	0 358	0 296	0 216	0 228	0 350	0 208	0 034	0 285	0 486	0 055	0 295	%MALE
%15-64	0 055	0 031	0 014	0 275	0 251	0 126	0 401	0 415	0 253	0 088	0 199	0 211	0 333	0 144	0 144	0 523	0 206	0 116	0 510	0 478	0 160	0 582	0 704	%15-64
%RURAL	0 057	0 162	0 150	0 346	0 111	0 036	0 095	0 227	0 088	0 242	0 181	0 189	0 138	0 172	0 250	0 115	0 173	0 082	0 276	0 149	0 201	0 361	0 097	0 332	%RURAL
Labour& employment
%UNEMPL	0 120	0 102	0 109	0 129	0 195	0 168	0 216	0 296	1 130	0 018	0 093	0 015	0 244	0 124	0 292	0 263	0 296	0 154	0 103	0 190	0 088	0 009	0 455	0 382	0 44	%UNEMPL
AGREMPL	0 115	0 138	0 200	0 412	0 016	0 127	0 182	0 137	0 181	0 073	0 102	0 083	0 080	0 048	0 094	0 290	0 085	0 059	0 477	0 329	0 015	0 570	0 206	0 561	0 783	0 260	AGREMPL
LABAGROW	0 036	0 113	0 077	0 156	0 033	0 004	0 003	0 089	0 032	0 005	0 148	0 041	0 118	0 009	0 032	0 047	0 123	0 113	0 069	0 029	0 068	0 158	0 136	0 047	0 236	0 291	0 260	LABAGROW
#DEPEND	0 055	0 003	0 017	0 217	0 197	0 026	0 431	0 437	0 262	0 127	0 217	0 204	0 316	0 116	0 146	0 503	0 229	0 142	0 476	0 480	0 168	0 503	0 721	0 929	0 189	0 501	0 414	0 135	#DEPEND
Economic production
GGP/CAP	0 028	0 024	0 039	0 007	0 096	0 005	0 272	0 351	0 351	0 044	0 093	0 079	0 111	0 007	0 005	0 266	0 158	0 060	0 298	0 394	0 119	0 309	0 506	0 705	0 284	0 404	0 404	0 070	0 690	GGP/CAP
AGRTOGP	0 017	0 061	0 084	0 346	0 055	0 080	0 308	0 228	0 286	0 191	0 102	0 251	0 151	0 008	0 056	0 338	0 036	0 002	0 487	0 420	0 029	0 638	0 376	0 694	0 581	0 035	0 035	0 186	0 593	0 598	AGRTOGGP
AGROWTH	0 000	0 178	0 134	0 175	0 135	0 342	0 229	0 153	0 041	0 152	0 148	0 260	0 089	0 018	0 106	0 192	0 259	0 063	0 172	0 215	0 182	0 225	0 041	0 017	0 091	0 182	0 182	0 216	0 043	0 151	0 283	AGROWTH
GGGROW	0 043	0 190	0 179	0 118	0 194	0 334	0 219	0 129	0 035	0 096	0 217	0 191	0 003	0 009	0 161	0 128	0 252	0 084	0 085	0 170	0 140	0 100	0 038	0 099	0 046	0 158	0 158	0 102	0 109	0 199	0 049	0 563

Table 7.8 Spearman rank correlations of degradation indices with biophysical climatic land use demographic labour and employment and economic production variables for magisterial districts, which have 80% or more of their land surface managed under ***marginal*** *land tenure systems. Degrees of freedom are 244 and for significance levels of p<05 0 01 and 0 001 r= 0124 0 162 and 0 206 respectively*

Degradation Indices																																
SDI	**SDI**																															
VDI	0 557	**VDI**																														
SDI+VDI	0 892	0 858	**SDI+VDI**																													
Biophysical variables																																
AREA	0 022	0 161	0 112	**AREA**																												
ALT	0 227	0 204	0 244	0 278	**ALT**																											
SLOPE	0 313	0 051	0 230	0 048	0 229	**SLOPE**																										
RUNOFF	0 011	0 313	0 156	0 052	0 261	0 590	**RUNOFF**																									
ERODE	0 159	0 075	0 048	0 069	0 093	0 263	0 289	**ERODE**																								
EFERTIL	0 106	0 058	0 111	0 227	0 031	0 002	0 123	0 360	**FERTIL**																							
Climatic variables																																
MAR	0 066	0 302	0 138	0 084	0 125	0 693	0 876	0 271	0 108																							
SAI	0 049	0 239	0 079	0 000	0 143	0 691	0 754	0 119	0 069	**SAI**																						
MAP:PET	0 109	0 202	0 032	0 181	0 259	0 567	0 602	0 220	0 051	0 639	**MAP:PET**																					
GROWDAYS	0 119	0 207	0 176	0 057	0 296	0 129	0 130	0 280	0 348	0 109	0 037	**GRWODAYS**																				
TMEAN	0 110	0 135	0 002	0 114	0 611	0 475	0 299	0 373	0 371	0 299	0 101	0 764	**TIMEAN**																			
Land use																																
MERCIAL	0 133	0 022	0 061	0 203	0 167	0 119	0 174	0 367	0 220	0 156	0 150	0 169	0 097	**MERCIAL**																		
%CROPS	0 155	0 584	0 399	0 154	0 125	0 010	0 299	0 121	0 083	0 244	0 109	0 028	0 080	0 064	**%CROPS**																	
%VELD	0 214	0 755	0 514	0 212	0 075	0 162	0 368	0 133	0 055	0 384	0 317	0 167	0 255	0 041	0 751	**%VELD**																
%FOR	0 179	0 407	0 309	0 057	0 035	0 429	0 629	0 336	0 273	0 434	0 343	0 556	0 594	0 090	0 253	0 370	**%FOR**															
%CON	0 009	0 218	0 135	0 346	0 104	0 451	0 292	0 247	0 064	0 281	0 163	0 243	0 337	0 127	0 255	0 222	0 306	**%CON**														
%SET	0 020	0 326	0 181	0 262	0 160	0 0074	0 122	0 079	0 097	0 081	0 241	0 131	0 087	0 201	0 075	0 537	0 017	0 084	**%SET**													
%OTH	0 086	0 085	0 009	0 223	0 024	0 106	0 227	0 310	0 130	0 056	0 061	0 317	0 332	0 185	0 105	0 039	0 307	0 225	0 152	**%OTH**												
LSU/HA	0 145	0 165	0 017	0 098	0 069	0 516	0 727	0 500	0 319	0 566	0 455	0 203	0 456	0 218	0 180	0 232	0 556	0 362	0 027	0 387	**LSU/HA**											
Demographic																																
%UNEMPL	0 119	0 019	0 070	0 625	0 248	0 014	0 058	0 100	0 307	0 060	0 198	0 233	0 207	0 241	0 079	0 095	0 207	0 175	0 247	0 130	0 123	**POPDEN**										
%MALE	0 020	0 251	0 117	0 292	0 106	0 315	0 389	0 458	0 212	0 329	0 205	0 335	0 364	0 153	0 136	0 184	0 563	0 101	0 021	0 226	0 496	0 388	**%MALE**									
%15-64	0 056	0 112	0 020	0 236	0 006	0 104	0 157	0 391	0 272	0 021	0 044	0 252	0 194	0 230	0 029	0 032	0 355	0 056	0 089	0 311	0 294	0 410	0 688	**%15-64**								
%RURAL	0 152	0 057	0 086	0 153	0 111	0 275	0 360	0 166	0 021	0 344	0 206	0 067	0 026	0 310	0 016	0 001	0 169	0 009	0 056	0 039	0 387	0 227	0 610	0 454	**%RURAL**							
Labour& employment																																
%UNEMPL	0 172	0 313	0 264	0 128	0 140	0 025	0 137	0 151	0 115	0 003	0 126	0 320	0 183	0 026	0 251	0 348	0 322	0 035	0 196	0 076	0 053	0 005	0 089	0 059	0 109	**%UNEMPL**						
AGREMPL	0 172	0 380	0 283	0 292	0 038	0 302	0 482	0 246	0 127	0 301	0 219	0 427	0 374	0 050	0 232	0 258	0 651	0 651	0 148	0 306	0 374	0 432	0 651	0 658	0 473	0 310	**AGREMPL**					
LABAGROW	0 150	0 316	0 267	0 236	0 041	0 134	0 284	0 168	0 159	0 045	0 214	0 614	0 425	0 036	0 055	0 206	0 505	0 505	0 236	0 245	0 202	0 017	0 318	0 327	0 012	0 349	0 310	**LABAGROW**				
#DEPEND	0 072	0 151	0 035	0 153	0 068	0 307	0 309	0 350	0 027	0 221	0 084	0 185	0 251	0 279	0 175	0 079	0 360	0 360	0 127	0 309	0 374	0 317	0 674	0 765	0 558	0 002	0 349	0 185	**#DEPEND**			
Economic production																																
GGP/CAP	0 270	0 128	0 230	0 055	0 047	0 288	0 289	0 084	0 051	0 320	0 070	0 214	0 013	0 295	0 012	0 166	0 026	0 026	0 161	0 214	0 166	0 421	0 042	0 218	0 336	0 487	0 469	0 262	0 205	**GGP/CAP**		
AGRTOGP	0 106	0 173	0 147	0 195	0 109	0 199	0 33	0 032	0 157	0 250	0 167	0 104	0 092	0 054	0 054	0 017	0 268	0 268	0 045	0 032	0 181	0 269	0 355	0 322	0 390	0 479	0 009	0 251	0 251	0 311	**AGRTOGGP**	
AGROWTH	0 045	0 142	0 084	0 130	0 079	0 119	0 261	0 373	0 252	0 203	0 075	0 033	0 137	0 030	0 217	0 165	0 318	0 318	0 150	0 138	0 064	0 361	0 228	0 307	0 312	0 142	0 022	0 265	0 265	0 275	0 156	**AGROWTH**
GGGROW	0 064	0 324	0 190	0 196	0 032	0 176	0 410	0 385	0 372	0 296	0 092	0 255	0 355	0 060	0 236	0 277	0 516	0 516	0 361	0 038	0 137	0 469	0 268	0 446	0 388	0 181	0 064	0 014	0 014	0 352	0 142	0 746

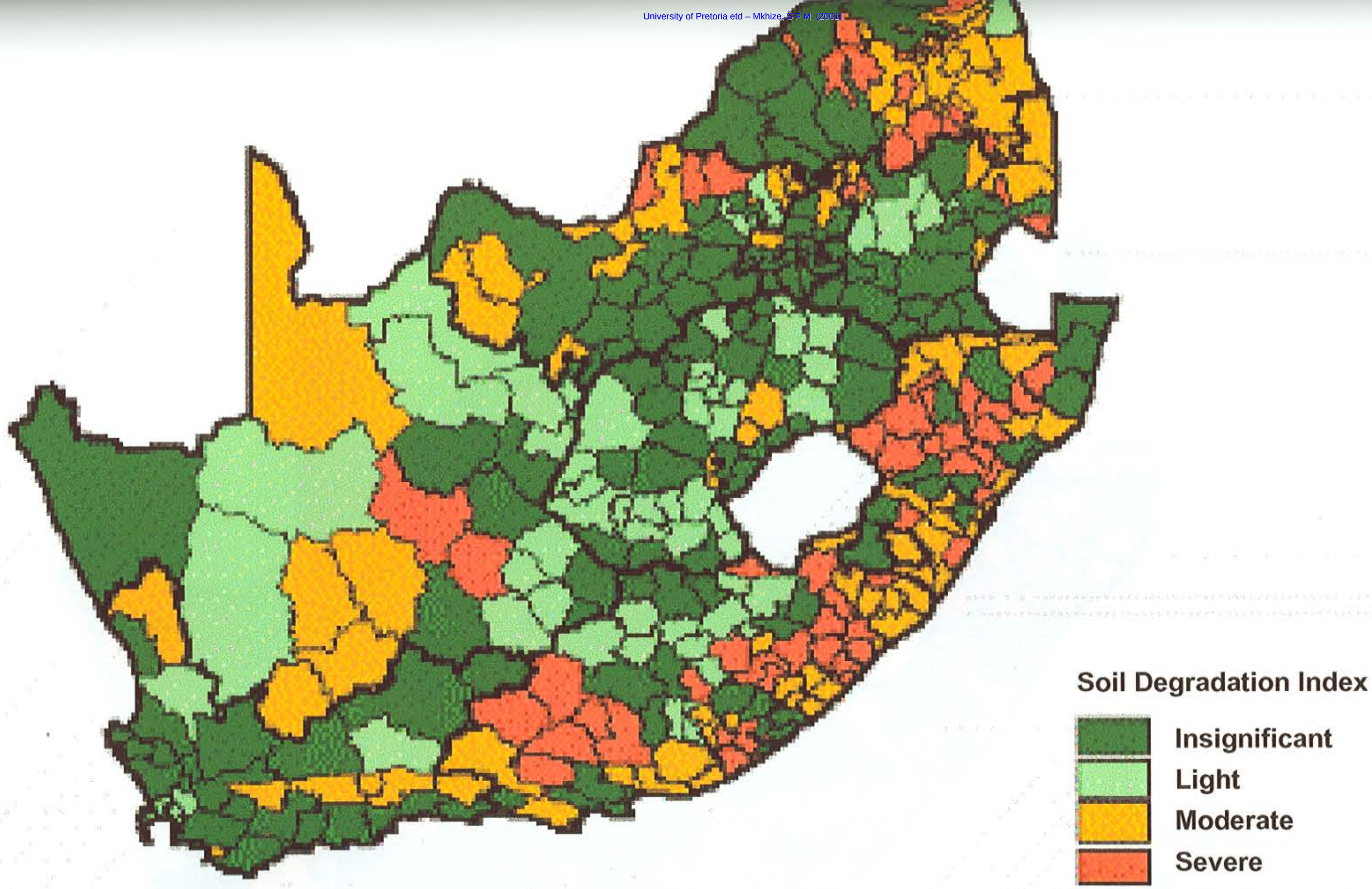

Figure 7.2: Magisterial Districts identifying degradation scores (soil degradation index)

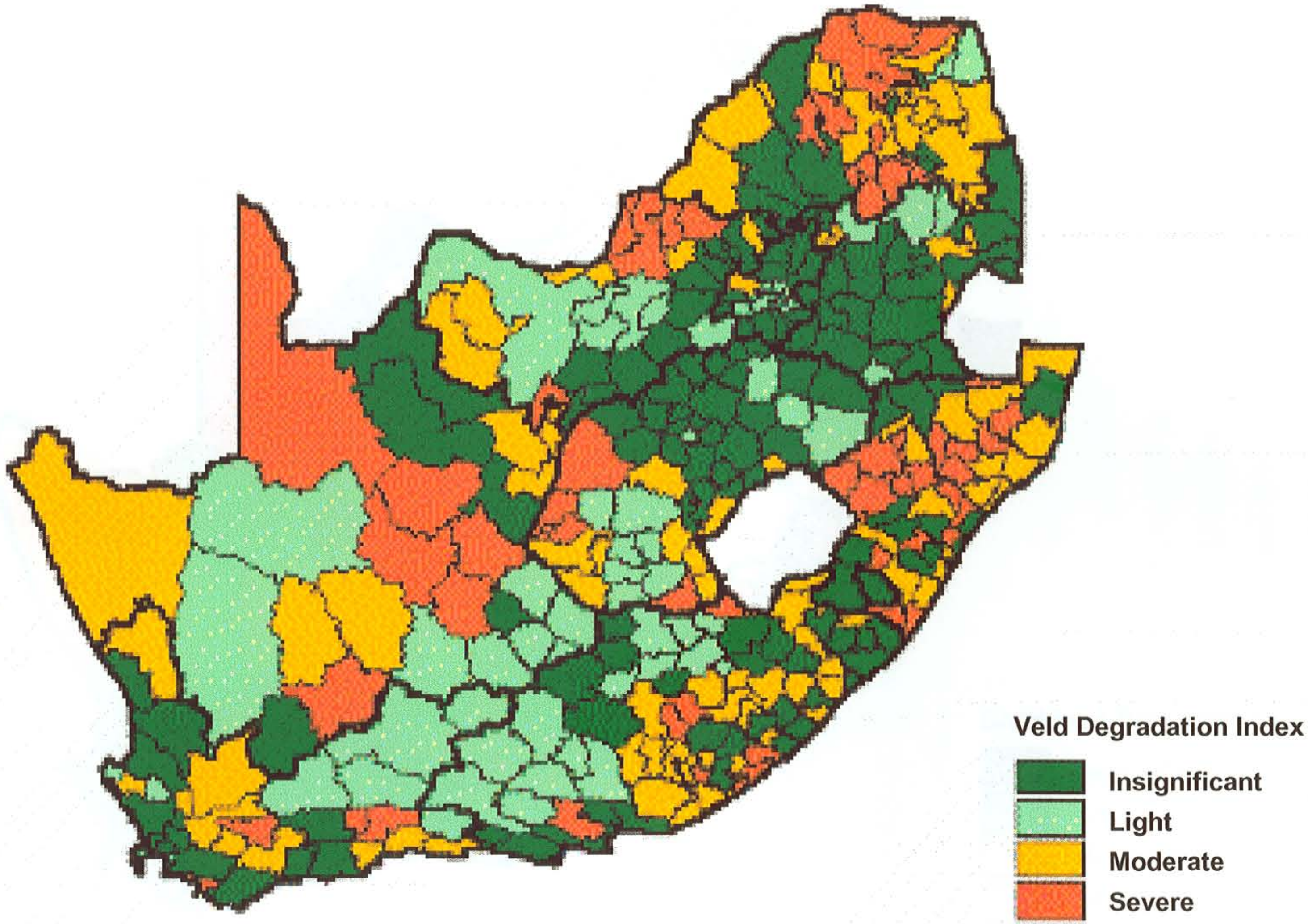

Figure 7.3: Magisterial Districts identifying degradation scores (veld degradation index)

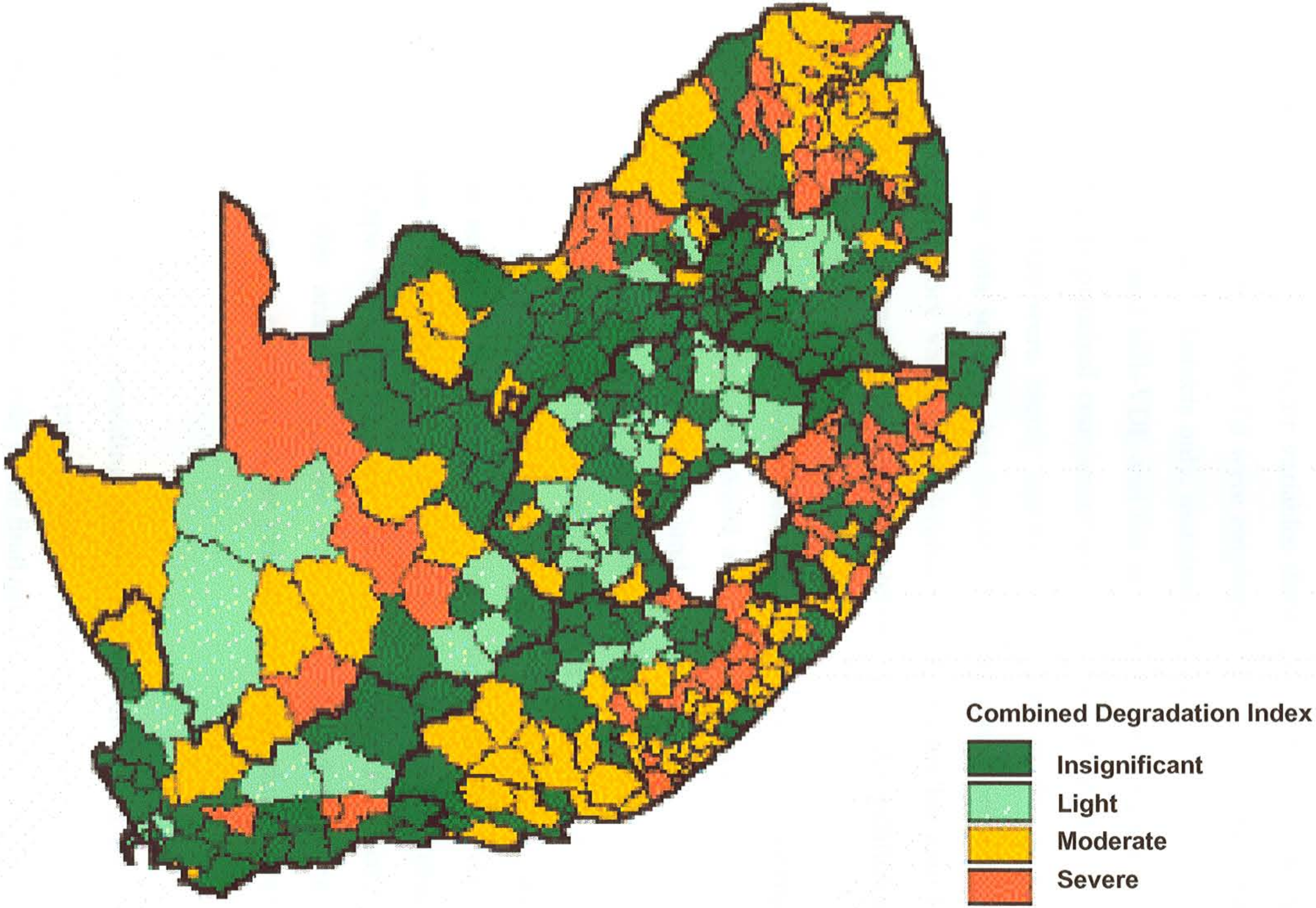

Figure 7.4: Magisterial Districts identifying degradation scores (combined degradation index)

7.4 The selection of land degradation priority areas

In this analysis both the degradation scores generated from the workshops as well as the important predictor variables developed in the nine regression models and outlined in *Table 7.5* were employed. In three separate analyses, (full data set, favoured districts only, marginal districts only) the degradation indices (SDI, VDI, and SDI+VDI) and the set of relevant predictor variables were subjected to principal component coordination analysis (PCA). In all cases the first axes were highly significantly related to the degradation gradient in the data set but also frequently incorporated other factors as significant explanatory variables. Individual district scores for axis 1 were then used to rank the magisterial districts in terms of their degradation status.

The results indicate that when considering all districts, as well as the marginal areas, the Eastern Cape, KwaZulu Natal and the Northern Province possess districts with the highest levels of land degradation. The North West Province, and to a limited extent also Mpumalanga, have one or two priority districts. When considering the FA on their own, it is again KwaZulu Natal which features prominently in the analysis. The Northern Cape also dominates in terms of the number of high priority districts. Magisterial districts in the Little Karoo of the Western Cape as well as isolated districts in the Eastern Cape, Northern Province and the North West Province are also important. In this analysis the Free State, Gauteng and to some extent Mpumalanga possess relatively fewer priority land degradation areas than other provinces.

Despite the attempts at providing some level of scientific rigour to the selection of high degradation priority areas, additional factors not considered here, will play an important role in the final set of districts selected as priority areas. Institutional capacity, levels of conflict within a district and rehabilitation potential are only some of the many factors, which could be considered by provincial and national degradation programmes. It is not a trivial task to decide on the districts and areas within the districts, which are most deserving of attention. Limited budgets make the selection and prioritisation of key areas even more crucial.

Table 7.9: The 17 magisterial districts in (Eastern Cape, KwaZulu Natal and Northern Province) identified as being priority areas in terms of their current and potential degradation status as determined by their soil, veld and combined degradation scores as well as by their values for key degradation predictor variables identified in the regression models in Table 7.4. Degradation scores and values for predictor variables were subjected to Principle Components Analysis. The 17 districts with the highest scores on Axis 1 are shown below. Axis reflects the land degradation gradient in the data set

All districts (n =348)	Favoured (>80%) (n =226)	Marginal (>80%) (n =89)
Eastern Cape (8)	Eastern Cape (1)	Eastern Cape (1)
Engcobo	Komga	Herschel
Middledrift		
Herschel		
Mount Ayliff		
Mount Fletcher		
Mqanduli		
Qumbu		
Xhora		
KwaZulu Natal (7)	KwaZulu Natal (4)	KwaZulu Natal (8)
Mahlabathini	Glencoe	Mahlabathini
Maphumulo	Kliprivier	Maphumulo
Msinga	Ngotshe	Msinga
Nkandla	Weenen	Ndwedwe
Nongoma		Nkandla
Nquthu		Nongoma
Weenen		Nquthu
		Pholela
Northern Province (5)	Northern Province (2)	Northern Province (8)
Mutale	Messina	Mankweng
Naphuno 2	Phalaborwa	Mokereng 2
Praktiseer		Mutale
Schoonoord		Nebo
Sekgosese		Praktiseer
		Schoonoord
		Sekgosese 1
		Seshego

7.5 Conclusions

The picture of land degradation, which has emerged from this analysis, differs from earlier studies in several important ways. The focus of the land degradation debate has historically been on the arid and semi-arid areas. While it has raised the profile of the desertification debate nationwide, it has also prevented other degradation issues from emerging from fuller synthesis of the problem. The study suggests that while biophysical environment and climatic and human impacts are all-important influences, land degradation ultimately occurs within the key natural resources of water, soil and vegetation. They all deserve equal status until such time as the interrelationships between all three are better understood and proper hierarchies of control, influence and interaction are developed. Until now, vegetation degradation has been the dominant player in the land degradation debate. This conceptual and theoretical imbalance needs to be addressed. National databases are still being developed and the rural and marginal areas have been severely neglected in the past.

The study has shown that soil degradation is perceived as being significantly greater in the marginal areas than in the FA. The map generated from the study suggests that it is largely in the MA, and especially the grazing lands which are situated along the steep slopes of the escarpment in the eastern parts (Eastern Cape, Northern Province, and KwaZulu Natal) that the problems are greatest. The analysis suggests that magisterial districts can, in fact, exist as islands of degradation in a relatively broad matrix of less degraded rangeland. Each district is different and possesses a unique suite of biophysical, climatic, socio-economic and historical characteristics. All these issues are important if we are to understand the problem of land degradation.

Although vegetation is significantly greater in MA than in FA, the relationship is not as tightly coupled to the land tenure system as it is for soil degradation. When soil and vegetation were considered together in a single combined index of degradation the Eastern Cape, KwaZulu Natal and Northern Province were the three provinces with the highest levels of degradation. All have significant areas managed under a marginal land tenure system. Overall, combined soil is perceived to be more than twice as great in MA than in FA.

In this study the biophysical environment is perceived as a filter through which climatic and human impacts have an effect on water, soil and vegetation resources. The exact nature of the biophysical environment, however, appears an important determinant of land degradation in both FA and MA. The regression models in this study suggest that areas with steep slopes, low annual rainfall total (especially in marginal areas) and high temperatures, are significantly more degraded than other districts. The biophysical environment should therefore not be ignored in assessments of land degradation and especially in developing action programmes to deal with the problem. Climatic impacts on land degradation are difficult to assess. Historically, South Africans have rejected the hypothesis that changing climatic patterns, especially rainfall, are responsible for land degradation. This study finds continued support for this view but also notes that the last fifteen years, and especially the first half of the 1990s, have been unexpectedly dry. It is still not certain whether this is part of "normal" interdecal variability or whether there has been a significant and sustained decline in rainfall, which will continue into future.

Studies on changing temperatures suggest that there has been an increase in mean annual temperatures over Southern Africa this century and this is likely to rise even more into the future as a result of changes in green house gases. This is likely to impact severely on the land degradation status since both high temperature and low rainfall are significantly related to high levels of soil and vegetation degradation. There is an urgent need to better understand the interrelationship between climate and degradation. A complex and interrelated bundle of factors defines the role of people in land degradation in South Africa. While biophysical factors most directly explain the physical manifestations of land degradation, human actions and circumstances have a wide range of intricately interrelated, direct and indirect influences on the biophysical factors. In seeking to identify and understand the key of the role of people in South African land degradation, the analysis has been able to describe a central chain of causative links.

The nation's land allocation history must be our starting point. Rooted in South Africa's political experience, this history does much to explain the distribution, economic opportunities and land use practices of the rural population. Most directly, the history of land allocation leads to national demography and settlement patterns as the second causative link in the chain. The spatial variations in population density gender balance and age distribution between areas of favoured and marginal land tenure directly influence the ways in which land is used. However, the linkages between demography and land use practice (and hence, potentially, with land degradation) are not direct. Whether higher population densities have led to sustainable agricultural intensification or land degradation depends on two intermediate links in the chain of causation. The first of these is the land use policy that successive South African governments have applied. This analysis shows that in the favoured farming areas, this policy was at least partially conducive to sustainable land use; but that, in the MAs, it was not. The fourth link in the chain, and the second intermediate link between demography and land use practice, is the nature of rural livelihoods. Influenced by demography, economics and land use policy, the structure of marginal area livelihoods is shown to inhibit sustainable land use. The period when these livelihoods were most conducive to land degradation, may now be over. Many marginal areas are now significantly 'underfarmed'. Biomass extraction for fuel purposes, however, remains a significant threat to the natural resource base.

The most direct human contribution to land degradation, and hence the final link in the causative chain the study has identified, is land use practice. Influenced most directly by the structure and status of livelihoods, and in turn also by land policy, land use practice in the favoured farming areas has been to some extent. While farmers have contributed to widespread land degradation, conservation policies have had at least some effect in slowing that degradation and enhancing sustainable land use practice. In MA, the status of livelihoods and policy for most of this century has meant that field crop cultivation, livestock raising and the collection of fuel and other plant material have been conducive to land degradation. The above analysis does not suggest that favoured areas should now be abandoned. On the contrary, the approach should be strengthening our understanding of land degradation processes and the causes for the whole country. The interaction between favoured and marginal areas will become increasingly important in the future.

Finally, when analysed on a provincial basis, the Northern Province and KwaZulu Natal emerged as the two provinces with the highest mean CDI values followed by the Eastern Cape (*Table 7.1*). MAs in the Northern Province are perceived as being severely degraded, often for very different reasons. In many instances some of the most degraded districts, in the country are located adjacent to magisterial districts which are perceived to be relatively undegraded. Although there are many exceptions to the general rule, it appears that marginal areas in South Africa are perceived to be more degraded than favoured areas if soil and vegetation degradation are the assessment criteria.