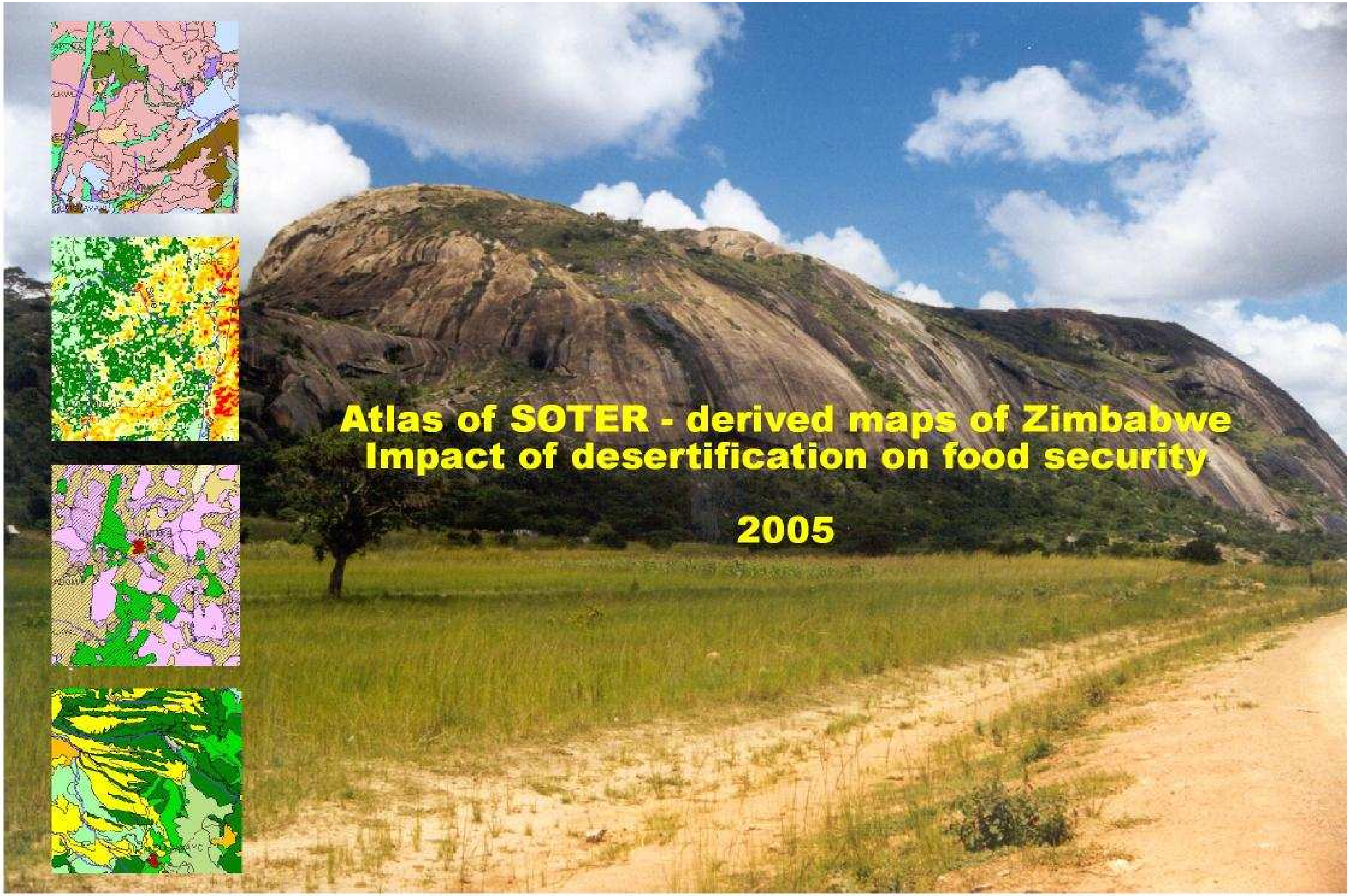

Atlas of SOTER - derived maps of Zimbabwe
Impact of desertification on food security

2005

World Soil Information

Department of Research and Specialist Services
Chemistry and Soil Research Institute

United Nations Environment Programme

Content **Page**

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Preface

This atlas presents several maps developed in the framework of a UNEP-funded project ‘The Impact of Desertification on Food Security in Southern Africa: a Case Study in Zimbabwe’, in which the impacts of dryland degradation (desertification) on productivity in Southern Africa were assessed, taking Zimbabwe as a case.

One of the major activities in the project was to compile a Soil and Terrain Database (SOTER) for Zimbabwe. This was done by the Soil Survey and Cartography Section of the Chemistry and Soil Research Institute of Zimbabwe with technical assistance of ISRIC – World Soil Information. The interpretation of the database was done by ISRIC; the procedures are detailed in:

van Engelen VWP, Mantel S, Dijkshoorn JA and Huting JRM, 2004. *The Impact of Desertification on Food Security in Southern Africa: a Case Study in Zimbabwe*. Report 2004/02, ISRIC – World Soil Information, Wageningen. [http://lime.isric.nl/Docs/ImpactStudyZimbabwe.pdf].

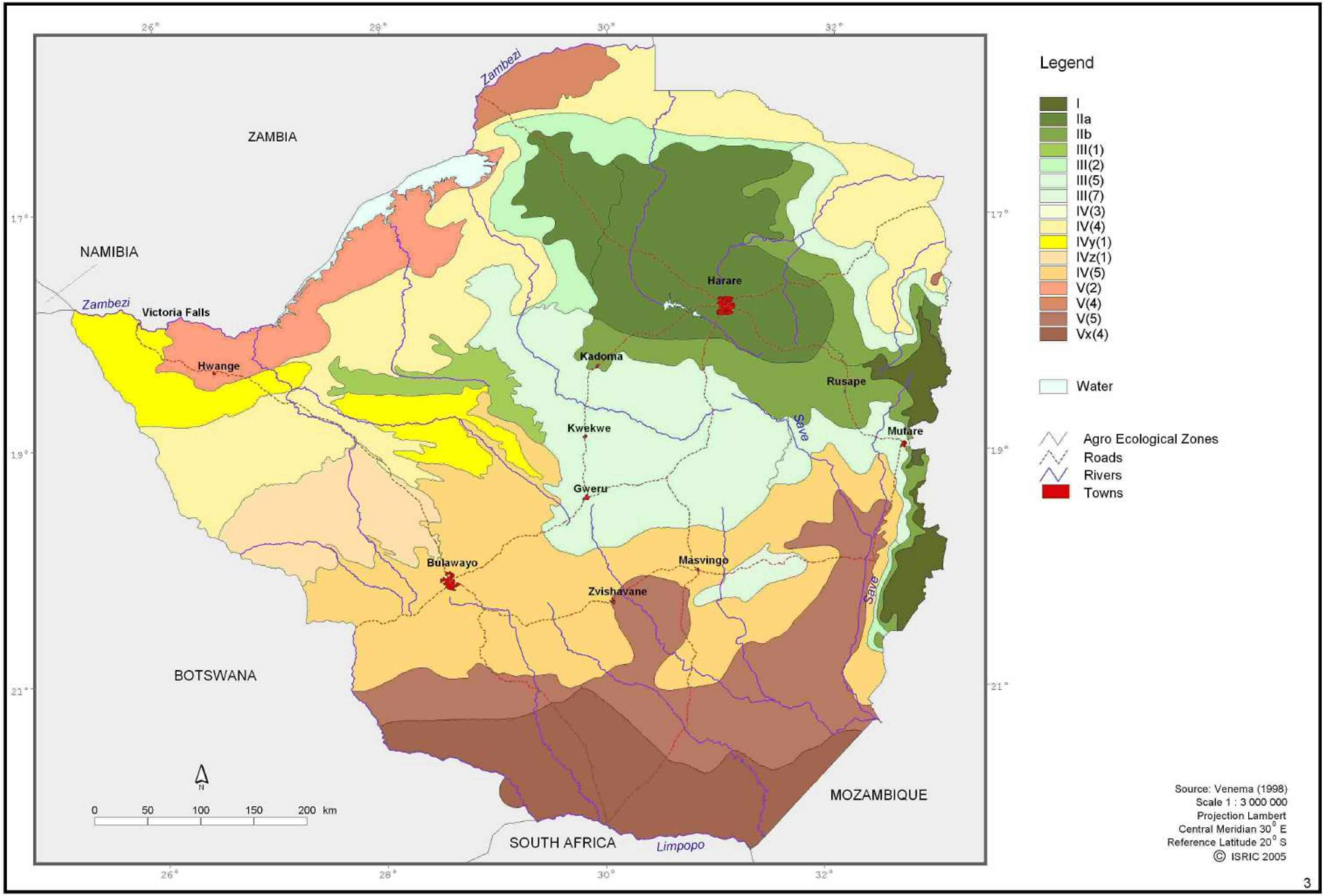
Map 1. Agro-Ecological Zone.

The climatic regions of Zimbabwe have been classified in various ways starting with the five natural regions based on annual rainfall, rainfall distribution and elevation (Department of the Surveyor General 1984). Later, moisture availability was used to define Agro-climatic Zones (Bernardi and Madzudzo 1990). These zones are based on the ratio of the 80% probability of the mean annual rainfall and the average annual evapotranspiration. The resulting six zones followed largely the natural regions with addition of a drier zone VI in the South. The characteristics of the natural regions have been further refined by Venema (1998) on the basis of moisture storage characteristics of the different soils as shown on the Provisional Soil Map of Zimbabwe (Department of Research and Specialist Services 1979) resulting in five major agro-ecological zones and 16 sub-zones (this map). Details are given in Table 1.

Table 1. Characteristics of the revised Agro-Ecological Zones. (Source: Venema 1998)

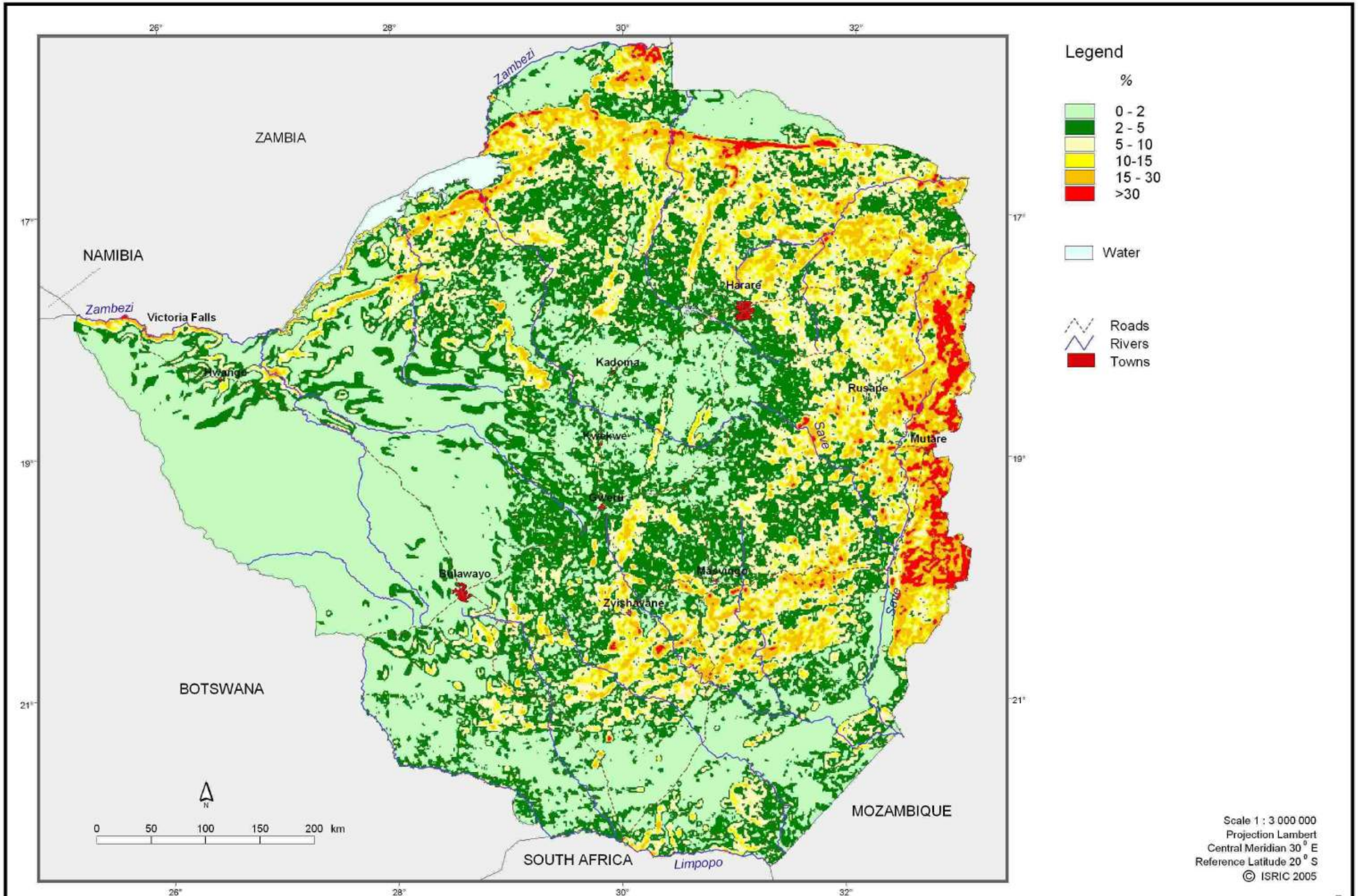
N.R. (1)	AEZ (2)	Probability of receiving > 500 mm (%) (3)	Probability of receiving > 750 mm (%) (4)	LGP_ days (5)	Soil_Code (6)	Soil_Description
I	I	> 90	80 - 90	170 - 200	7M	Red loams
IIa	IIa	> 90	60 - 70	140 - 170	5G/E,5AE,6G	Greyish brown sands/sandy loams derived from granites
IIb	IIb	80 - 90	50	120 - 150	5/6/7G	As above
III	III(1)	70 - 90	40 - 50	100 - 130	1,5M	Deep Kalahari Sand
III	III(2)	70 - 80	40	110	2,5M	Very shallow
III	III(5)	70 - 80	30 - 40	120 - 150	5G/M,6G,4E	Greyish brown sands/sandy loams derived from granites
III	III(7)	70 - 80	40	130	7G	Red loams
IV	IVy(1)	60 - 80	20 - 40	110 - 130	1,(2)	Deep Kalahari Sand
IV	IV(2)	55 - 70	10 - 20	100 - 130	2,(5M)	Very shallow
IV	IV(3)	30 _ 40	10	70 - 90	3B	Vertisols
IV	IV(4)	60 - 70	20 - 40	100 - 130	4/5M,1,4C,8	Brown loamy sands and loams
IV	IV(5)	40 - 65	10 - 30	100 - 135	5G,(4M/S/E)	Greyish brown sands derived from granitic rocks
IV	IVz(1)	50 - 65	10 - 20	90 - 115	1,(4M,3B)	Deep Kalahari Sand
V	Vx(4)	< 30	< 10	< 70	2,4P,1,4M	Variable
V	V(2)	60	20	100 - 130	2,(1)	Very shallow
V	V(3)	30 - 40	< 10	70 - 100	3B,2	Vertisols
V	V(4)	70 - 80	30	100 - 130	4M,2,(1,8)	Brown loamy sands and loams
V	V(5)	40 - 60	< 15	70 - 100	5G,4P,2,4M	Sands and sandy loams derived from granite and gneiss

Notes:
(1) Natural Regions (Department of the Surveyor General 1984)
(2) Agro-Ecological Zones (Venema 1998)
(3) Probability of receiving more than 500 mm rainfall during the period October to April
(4) Probability of receiving more than 750 mm rainfall during the period October to April
(5) Length of Growing Period (number of days that Precipitation exceeds half Potential Evapotranspiration)
(6) Provisional Soil Map of Zimbabwe at scale 1:1 000 000 (Department of Research and Specialist Services 1979)


26°
28°
30°
32°
17°
19°
21°
ZAMBIA
NAMIBIA
BOTSWANA
MOZAMBIQUE
SOUTH AFRICA
Zambezi
Zambezi
Limpopo
Save
Save
Victoria Falls
Hwange
Harare
Kadoma
Rusape
Kwekwe
Mutare
Gweru
Bulawayo
Masvingo
Zvishavane
0 50 100 150 200 km
N
Legend
I
IIa
IIb
III(1)
III(2)
III(5)
III(7)
IV(3)
IV(4)
IVy(1)
IVz(1)
IV(5)
V(2)
V(4)
V(5)
Vx(4)
Water
Agro Ecological Zones
Roads
Rivers
Towns
Source: Venema (1998)
Scale 1 : 3 000 000
Projection Lambert
Central Meridian 30° E
Reference Latitude 20° S
© ISRIC 2005

Map 2. Slope gradient classes derived from a 1 x 1 km DEM

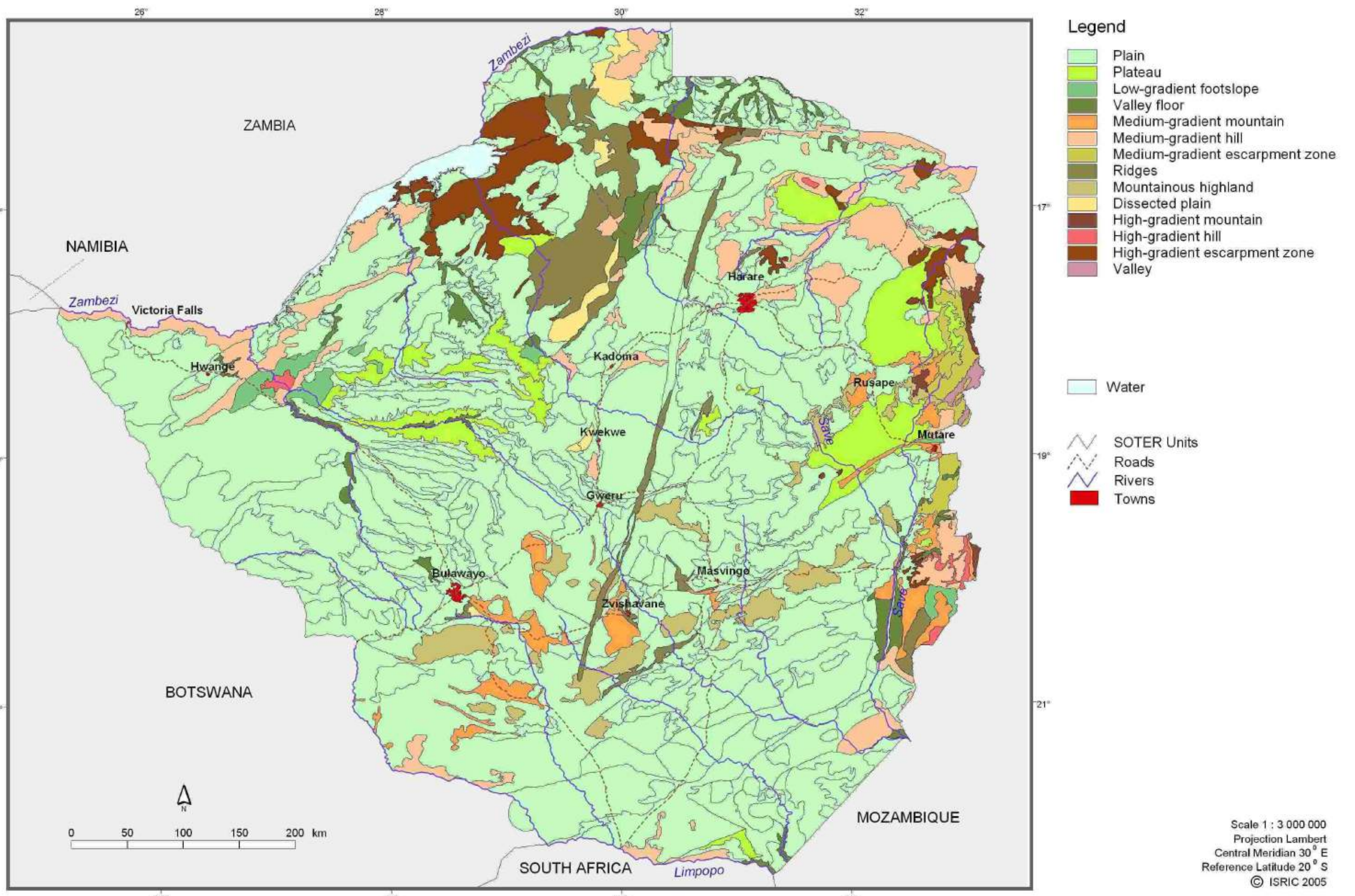
Slopes were calculated from the 1 x 1 km ETOPO30 digital elevation model - DEM (USGS 1997) and classified according to the SOTER slope classes (van Engelen and Wen 1995).


Legend
%
0 - 2
2 - 5
5 - 10
10-15
15 - 30
>30
Water
Roads
Rivers
Towns
ZAMBIA
NAMIBIA
BOTSWANA
MOZAMBIQUE
SOUTH AFRICA
Zambezi
Limpopo
Save
Victoria Falls
Hwange
Harare
Kadoma
Kwekwe
Gweru
Rusape
Mutare
Bulawayo
Masvingo
Zvishavane
0 50 100 150 200 km
26°
28°
30°
32°
17°
19°
21°
Scale 1 : 3 000 000
Projection Lambert
Central Meridian 30 ° E
Reference Latitude 20 ° S
© ISRIC 2005

Map 3. Major landform

General physical regions have been defined by Anderson *et al.* (1993), based on cycles of weathering, erosion and tectonic movement. Landform classification within these regions is based on the Soil and Terrain Database of Zimbabwe, compiled by the Soil Survey and Cartography Section of the Chemistry and Soil Research Institute

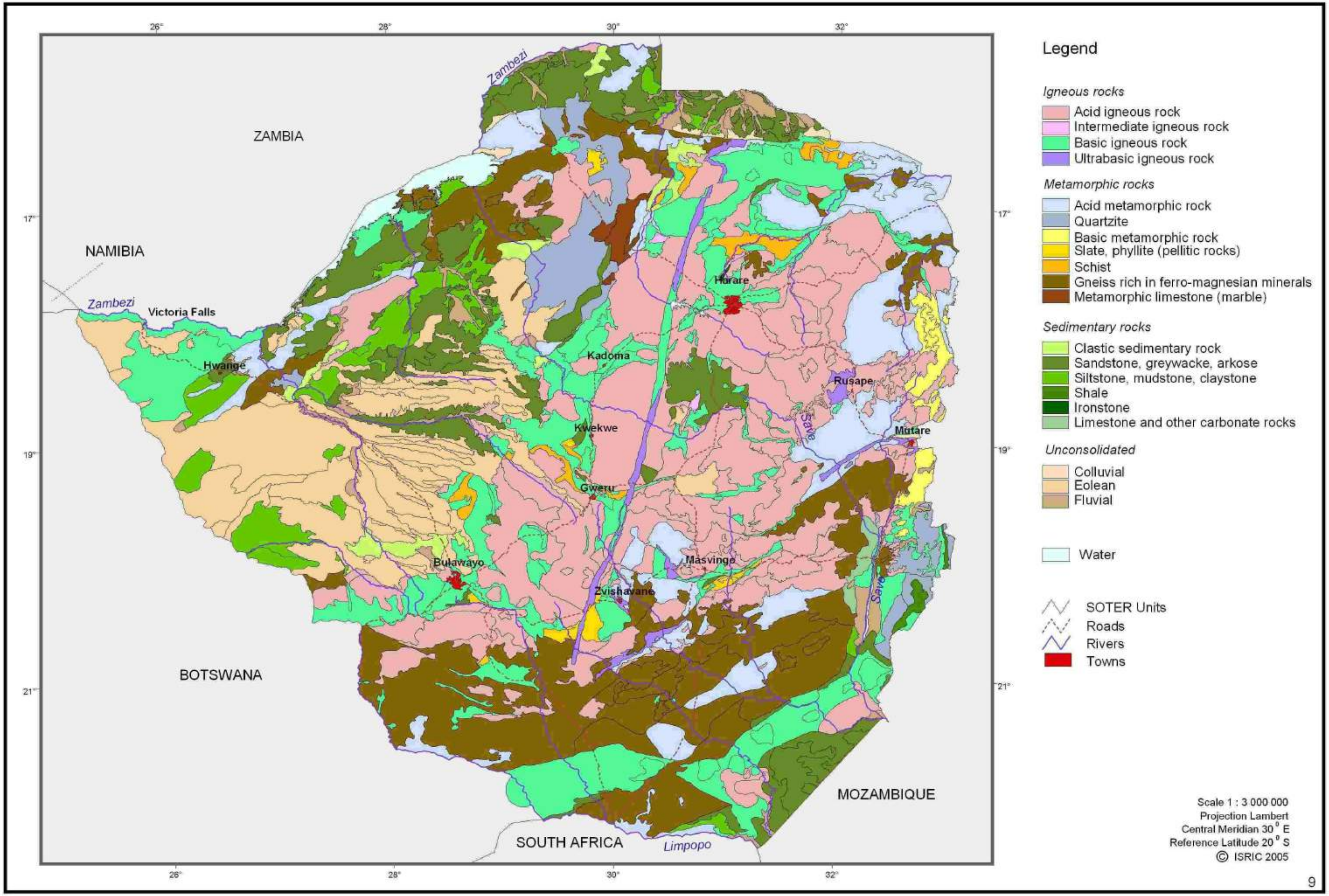
(FAO and ISRIC 2003). The landform terminology is detailed in the SOTER Procedures Manual (van Engelen and Wen 1995).



Legend
Plain
Plateau
Low-gradient footslope
Valley floor
Medium-gradient mountain
Medium-gradient hill
Medium-gradient escarpment zone
Ridges
Mountainous highland
Dissected plain
High-gradient mountain
High-gradient hill
High-gradient escarpment zone
Valley
Water
SOTER Units
Roads
Rivers
Towns
ZAMBIA
NAMIBIA
BOTSWANA
MOZAMBIQUE
SOUTH AFRICA
Zambezi
Limpopo
Save
Victoria Falls
Hwange
Harare
Kadoma
Kwekwe
Gweru
Rusape
Mutare
Masvingo
Bulawayo
Zvishavane
26°
28°
30°
32°
17°
19°
21°
N
0 50 100 150 200 km
Scale 1 : 3 000 000
Projection Lambert
Central Meridian 30° E
Reference Latitude 20° S
© ISRIC 2005

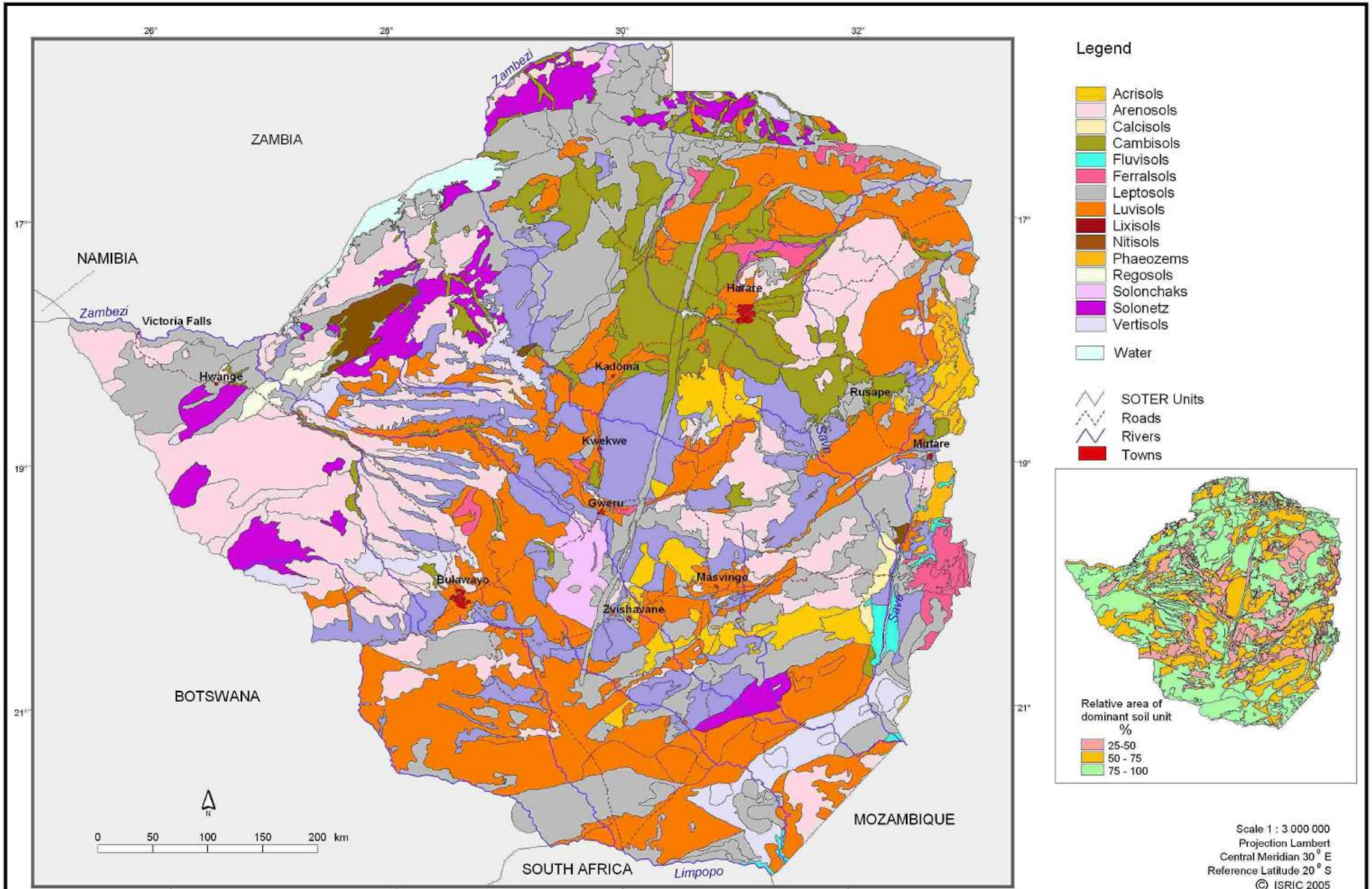
Map 4. Generalized lithology

General physical regions defined by Anderson *et al.* (1993) indicate the dominant geological formations and their lithology. Together with additional field information, the lithological data has been transferred to the Soil and Terrain Database of Zimbabwe (FAO and ISRIC 2003); the lithology classification is according to SOTER (van Engelen and Wen 1995).


26°
28°
30°
32°
17°
19°
21°
ZAMBIA
NAMIBIA
BOTSWANA
MOZAMBIQUE
SOUTH AFRICA
Zambezi
Limpopo
Save
Victoria Falls
Hwange
Harare
Kadoma
Kwekwe
Gweru
Rusape
Mutare
Bulawayo
Zvishavane
Masvingo
Legend
Igneous rocks
Acid igneous rock
Intermediate igneous rock
Basic igneous rock
Ultrabasic igneous rock
Metamorphic rocks
Acid metamorphic rock
Quartzite
Basic metamorphic rock
Slate, phyllite (pellitic rocks)
Schist
Gneiss rich in ferro-magnesian minerals
Metamorphic limestone (marble)
Sedimentary rocks
Clastic sedimentary rock
Sandstone, greywacke, arkose
Siltstone, mudstone, claystone
Shale
Ironstone
Limestone and other carbonate rocks
Unconsolidated
Colluvial
Eolean
Fluvial
Water
SOTER Units
Roads
Rivers
Towns
Scale 1 : 3 000 000
Projection Lambert
Central Meridian 30° E
Reference Latitude 20° S
© ISRIC 2005

Map 5. Dominant soils (1st level of WRB)

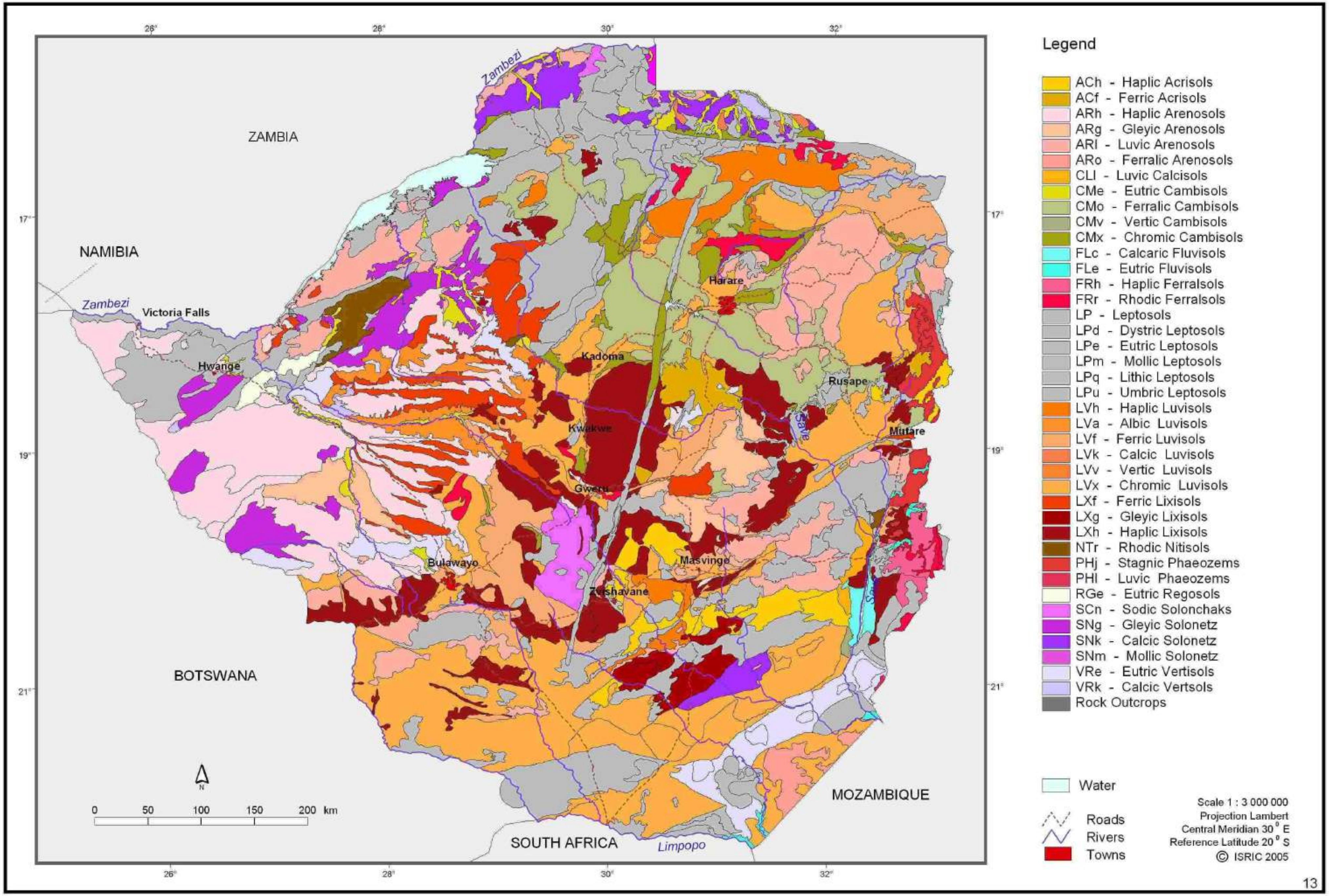
This map shows the dominant soils of each SOTER unit of Zimbabwe at the first level of the World Reference Base for Soil Resources (IUSS *et al.* 1998), as derived from the SOTER database (FAO and ISRIC 2003).



Legend
Acrisols
Arenosols
Calcisols
Cambisols
Fluvisols
Ferralsols
Leptosols
Luvisols
Lixisols
Nitisols
Phaeozems
Regosols
Solonchaks
Solonetz
Vertisols
Water
SOTER Units
Roads
Rivers
Towns
ZAMBIA
NAMIBIA
BOTSWANA
SOUTH AFRICA
MOZAMBIQUE
Zambezi
Limpopo
Save
Victoria Falls
Hwange
Kadoma
Harare
Rusape
Kwekwe
Mutare
Gweru
Bulawayo
Masvingo
Zvishavane
26°
28°
30°
32°
17°
19°
21°
0 50 100 150 200 km
Relative area of dominant soil unit %
25-50
50 - 75
75 - 100
Scale 1 : 3 000 000
Projection Lambert
Central Meridian 30 ° E
Reference Latitude 20 ° S
© ISRIC 2005

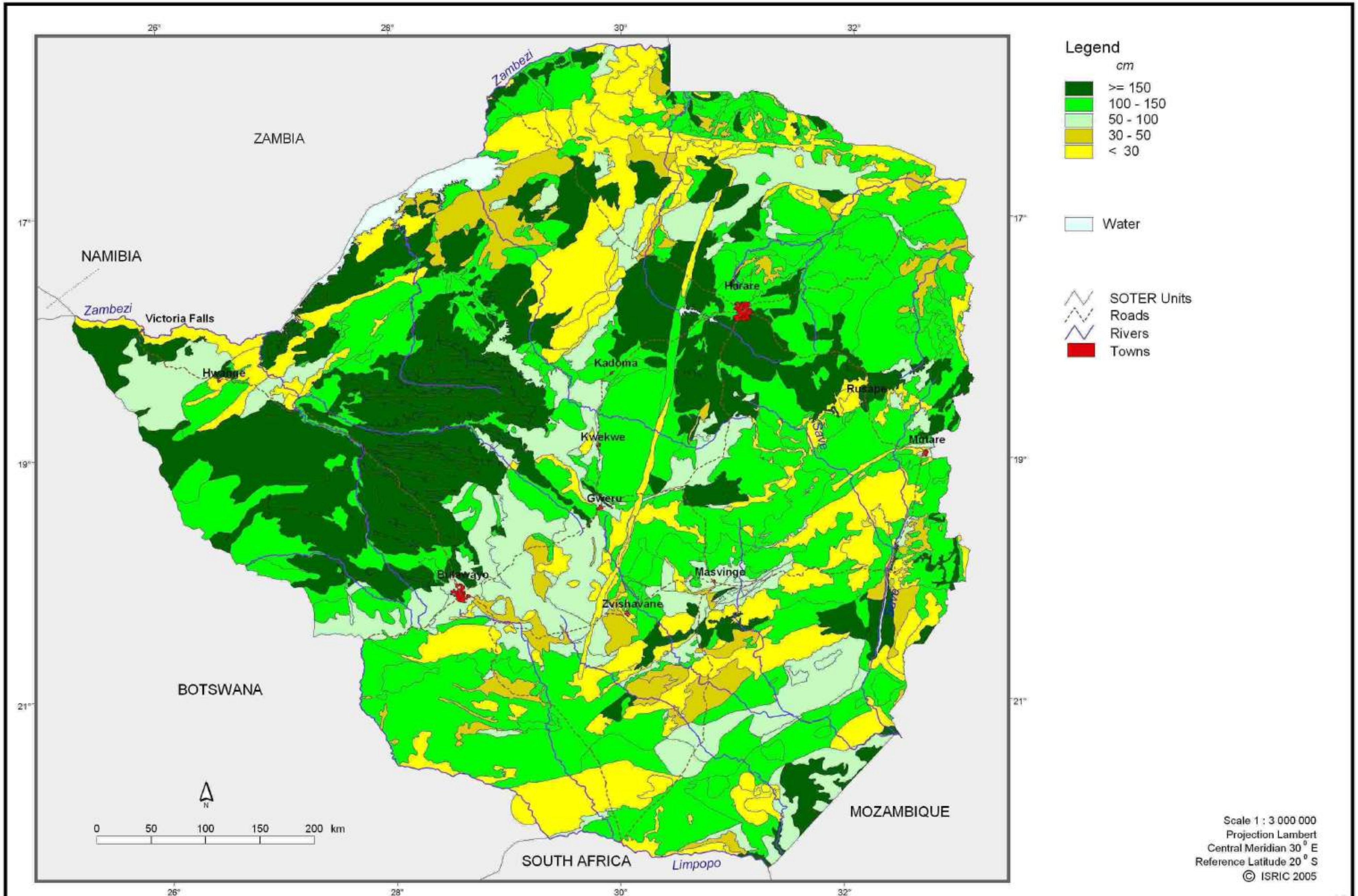
Map 6. Dominant soils (2nd level WRB)

This map shows the dominant soils of each SOTER unit of Zimbabwe at the second level of World Reference Base for Soil Resources (IUSS *et al.* 1998), as derived from the SOTER database (FAO and ISRIC 2003).


ZAMBIA
NAMIBIA
BOTSWANA
MOZAMBIQUE
SOUTH AFRICA
Zambezi
Limpopo
Victoria Falls
Hwange
Harare
Kadoma
Kwekwe
Gweru
Rusape
Mutare
Bulawayo
Masvingo
Zvishavane
26°
28°
30°
32°
17°
19°
21°
0 50 100 150 200 km
N
Legend
ACh - Haplic Acrisols
ACf - Ferric Acrisols
ARh - Haplic Arenosols
ARg - Gleyic Arenosols
ARl - Luvic Arenosols
ARo - Ferralic Arenosols
CLl - Luvic Calcisols
CMe - Eutric Cambisols
CMo - Ferralic Cambisols
CMv - Vertic Cambisols
CMx - Chromic Cambisols
FLc - Calcaric Fluvisols
FLe - Eutric Fluvisols
FRh - Haplic Ferralsols
FRr - Rhodic Ferralsols
LP - Leptosols
LPd - Dystric Leptosols
LPe - Eutric Leptosols
LPm - Mollic Leptosols
LPq - Lithic Leptosols
LPu - Umbric Leptosols
LVh - Haplic Luvisols
LVa - Albic Luvisols
LVf - Ferric Luvisols
LVk - Calcic Luvisols
LVv - Vertic Luvisols
LVx - Chromic Luvisols
LXf - Ferric Lixisols
LXg - Gleyic Lixisols
LXh - Haplic Lixisols
NTr - Rhodic Nitisols
PHj - Stagnic Phaeozems
PHl - Luvic Phaeozems
RGe - Eutric Regosols
SCn - Sodic Solonchaks
SNg - Gleyic Solonetz
SNk - Calcic Solonetz
SNm - Mollic Solonetz
VRe - Eutric Vertisols
VRk - Calcic Vertsols
Rock Outcrops
Water
Roads
Rivers
Towns
Scale 1 : 3 000 000
Projection Lambert
Central Meridian 30° E
Reference Latitude 20° S
© ISRIC 2005

Map 7. Depth of dominant soils

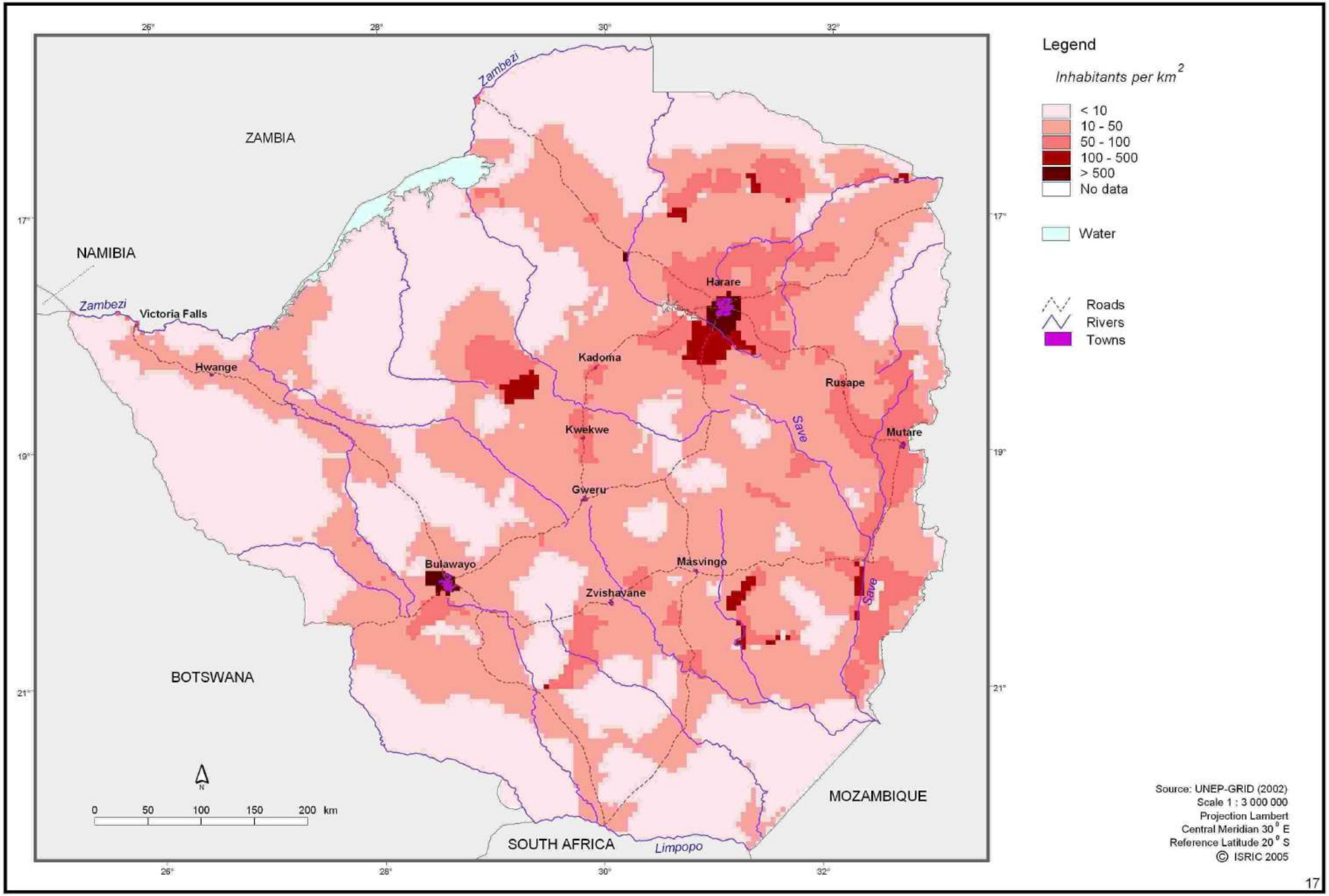
Soil depth is of importance for land suitability assessment and in crop growth simulation and water balance studies. The map shows the depth class (in cm) of the dominant soil of each mapping unit.



Legend
cm
>= 150
100 - 150
50 - 100
30 - 50
< 30
Water
SOTER Units
Roads
Rivers
Towns
ZAMBIA
NAMIBIA
BOTSWANA
MOZAMBIQUE
SOUTH AFRICA
Zambezi
Limpopo
Save
Victoria Falls
Hwange
Harare
Kadoma
Kwekwe
Gweru
Rusape
Mutare
Masvingo
Bulawayo
Zvishavane
0 50 100 150 200 km
N
Scale 1 : 3 000 000
Projection Lambert
Central Meridian 30 ° E
Reference Latitude 20 ° S
© ISRIC 2005

Map 8. Population density

The total population of Zimbabwe in 2002 was 11.6 million (Central Statistical Office 2002). Distribution of the population over the country is uneven with the highest densities in the wetter areas. The map shows the population density in a 25 km^2 grid (UNEP-GRID 2002).

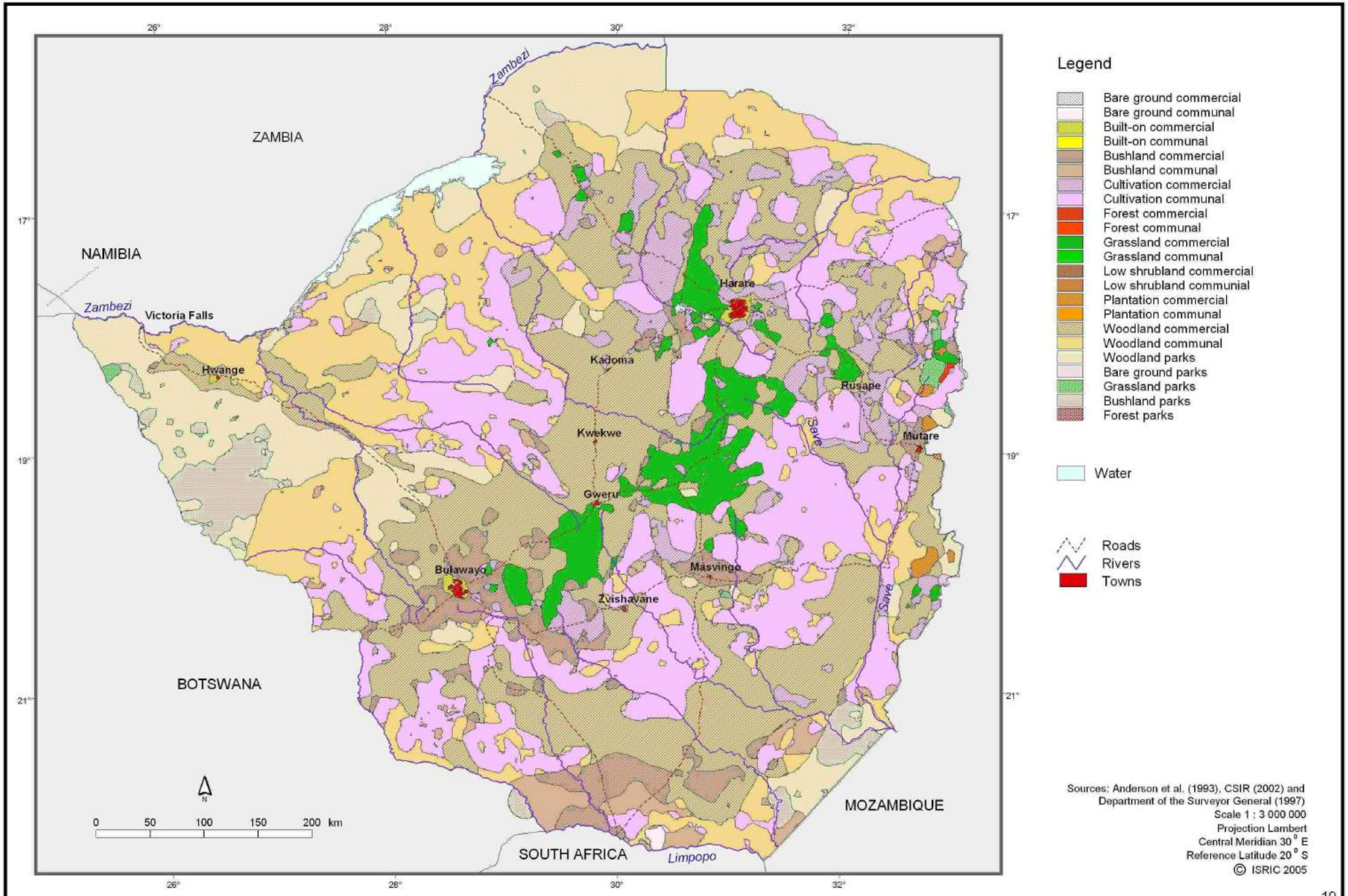

Legend
Inhabitants per km2
< 10
10 - 50
50 - 100
100 - 500
> 500
No data
Water
Roads
Rivers
Towns
ZAMBIA
NAMIBIA
BOTSWANA
SOUTH AFRICA
MOZAMBIQUE
Zambezi
Limpopo
Save
Victoria Falls
Hwange
Kadoma
Harare
Rusape
Mutare
Kwekwe
Gweru
Bulawayo
Masvingo
Zvishavane
26°
28°
30°
32°
17°
19°
21°
0 50 100 150 200 km
N
Source: UNEP-GRID (2002)
Scale 1 : 3 000 000
Projection Lambert
Central Meridian 30° E
Reference Latitude 20° S
© ISRIC 2005

Map 9. Land use

This map is based on a generalized version of the SADC Land Cover Dataset (CSIR 2002) which, in turn, is based on the land cover map of the Forestry Commission (1997). Added to his map are Communal Lands taken from the soil map of Anderson *et al.* (1993) and National Park and Nature Reserves from the Department of the Surveyor General (1997). Land use has been defined according to SOTER (van Engelen and Wen 1995) and the original land cover classes were transformed accordingly.

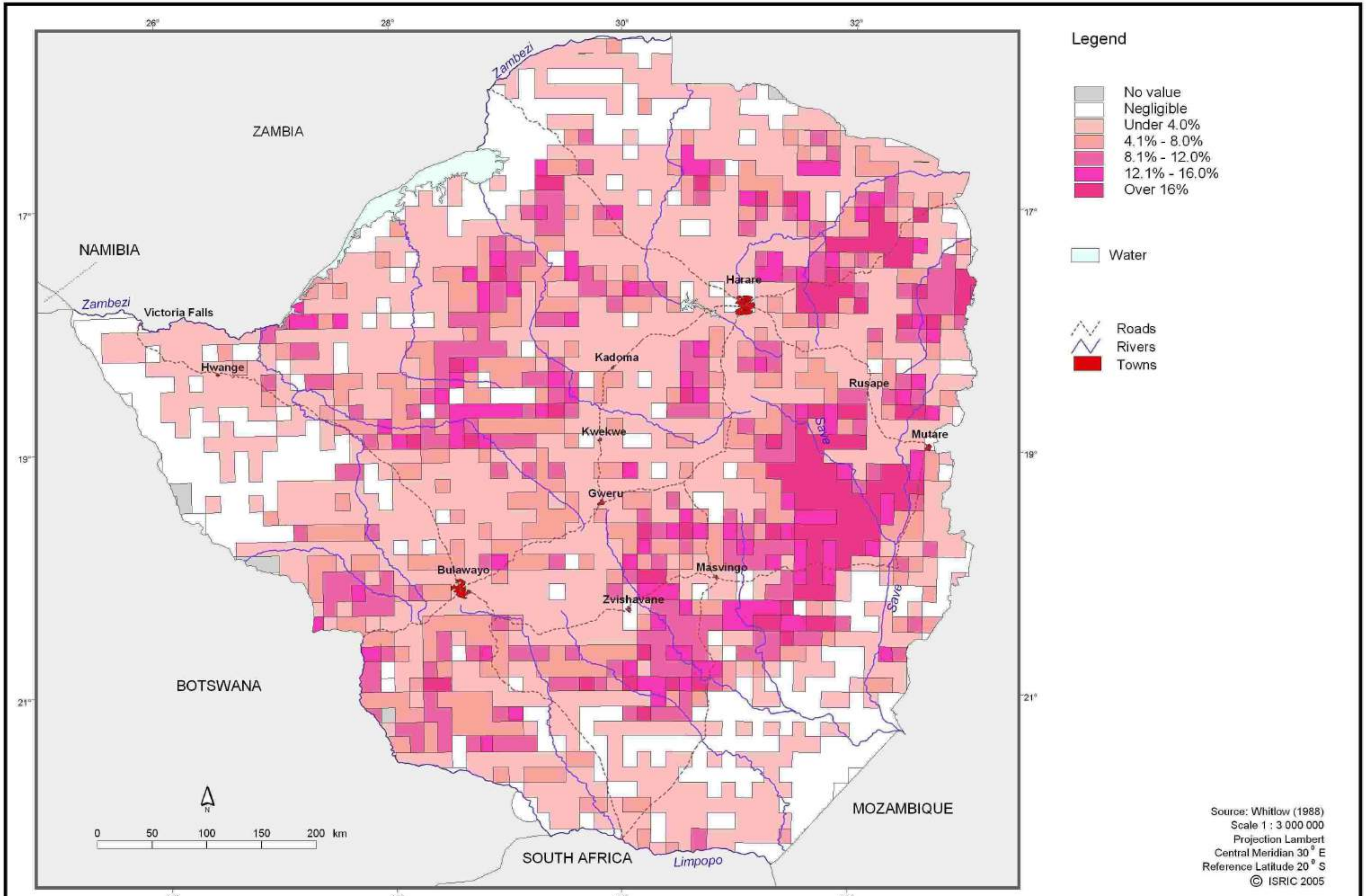
Maize is the major crop in Zimbabwe, in particular for Communal Land farmers; some 90% of the Communal Lands is used for this crop.

Recent changes in ownership of the majority of commercial farms have not been taken into account due to a lack of reliable data on the extent of the re-allocation and the new area under cultivation.


ZAMBIA
NAMIBIA
BOTSWANA
MOZAMBIQUE
SOUTH AFRICA
Zambezi
Limpopo
Save
Victoria Falls
Hwange
Harare
Kadoma
Kwekwe
Gweru
Rusape
Mutare
Bulawayo
Masvingo
Zvishavane
26°
28°
30°
32°
17°
19°
21°
Legend
Bare ground commercial
Bare ground communal
Built-on commercial
Built-on communal
Bushland commercial
Bushland communal
Cultivation commercial
Cultivation communal
Forest commercial
Forest communal
Grassland commercial
Grassland communal
Low shrubland commercial
Low shrubland communial
Plantation commercial
Plantation communal
Woodland commercial
Woodland communal
Woodland parks
Bare ground parks
Grassland parks
Bushland parks
Forest parks
Water
Roads
Rivers
Towns
0 50 100 150 200 km
N
Sources: Anderson et al. (1993), CSIR (2002) and
Department of the Surveyor General (1997)
Scale 1 : 3 000 000
Projection Lambert
Central Meridian 30° E
Reference Latitude 20° S
© ISRIC 2005

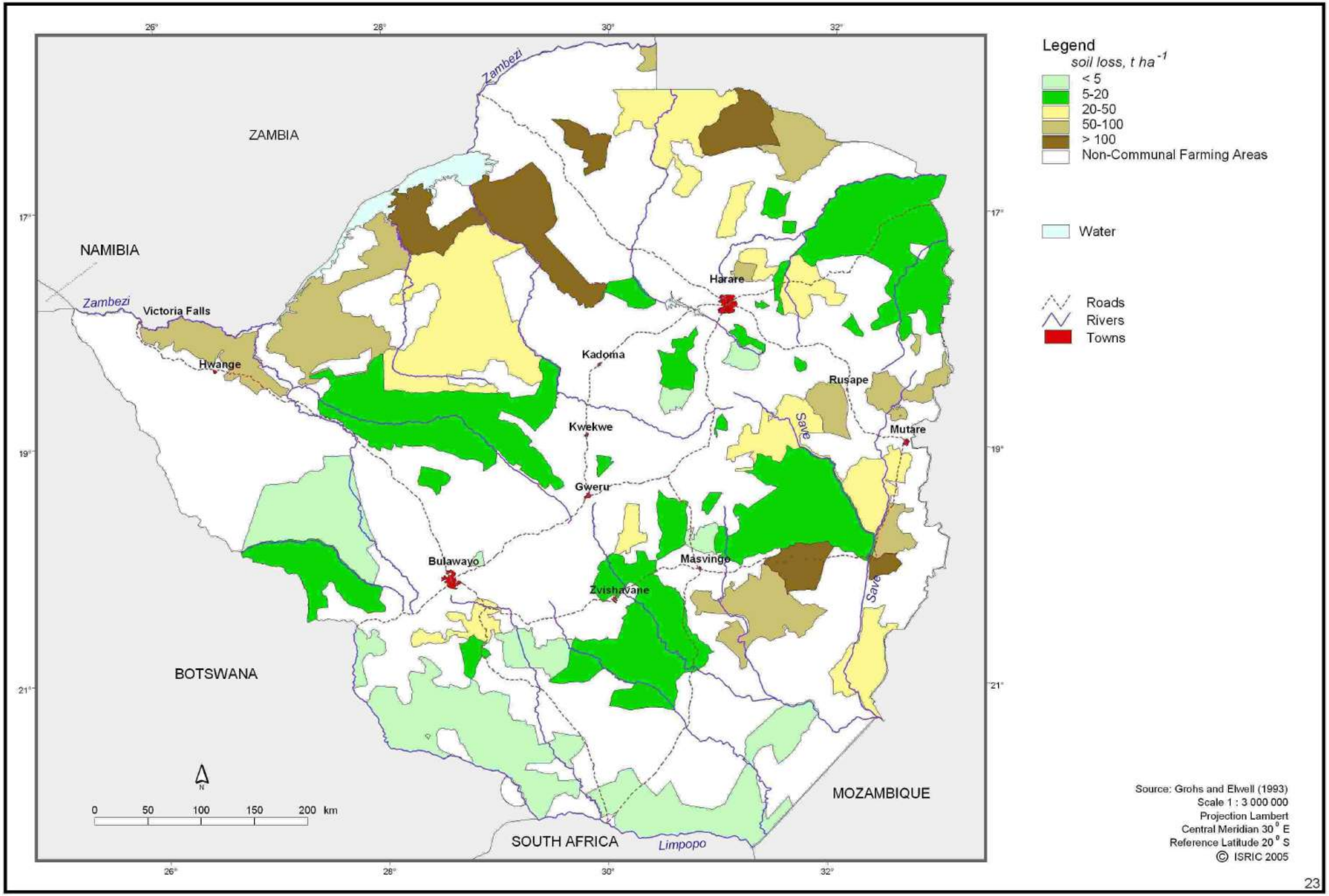
Map 10. Percentage of land eroded by water

Based on a selection of aerial photographs at scale 1:25 000, Whitlow (1988) made a national map on the area affected by soil erosion. The used method did not allow for mapping different kinds of soil erosion (rills, gullies, sheet erosion under different land uses), but generated ‘actual’ erosion by water in terms of total erosion, erosion on cropland and erosion on non-cropland. Taking into account the method of aerial photo interpretation, where slight erosion features might be difficult to identify, it is likely that the map underestimates the extent of water erosion.


Legend
No value
Negligible
Under 4.0%
4.1% - 8.0%
8.1% - 12.0%
12.1% - 16.0%
Over 16%
Water
Roads
Rivers
Towns
ZAMBIA
NAMIBIA
BOTSWANA
SOUTH AFRICA
MOZAMBIQUE
Zambezi
Zambezi
Save
Save
Limpopo
Victoria Falls
Hwange
Harare
Kadoma
Kwekwe
Gweru
Rusape
Mutare
Bulawayo
Masvingo
Zvishavane
26°
28°
30°
32°
17°
19°
21°
0
50
100
150
200 km
N
Source: Whitlow (1988)
Scale 1 : 3 000 000
Projection Lambert
Central Meridian 30° E
Reference Latitude 20° S
© ISRIC 2005

Map 11. Predicted annual erosion rate from the cropland of the Communal Lands

Water erosion processes in Zimbabwe have been studied extensively, in particular in the late 1950s and early 1960s, resulting in the Soil Loss Estimation Model for Southern Africa (SLEMSA) (Elwell 1982). Projected soil erosion risk has been mapped with this model by Grohs and Elwell (1993) for the Communal Lands (this map). The study projects an average annual soil loss from arable fields in the Communal Lands of 43 t ha^{-1}. Assuming an average bulk density of 1.3 kg dm^{-3} this can be translated to a projected soil loss of 3 mm yr^{-1}.

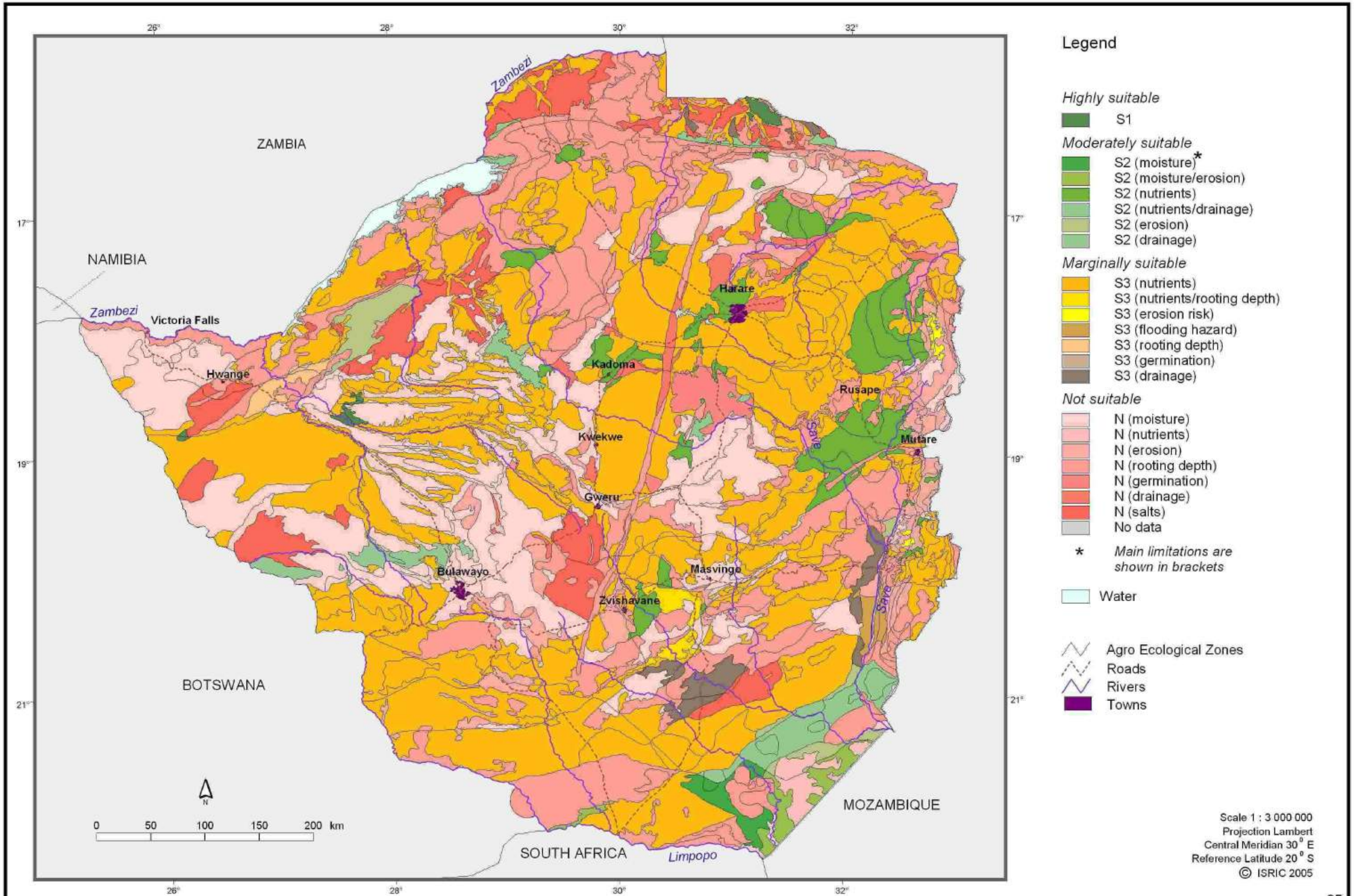

Legend
soil loss, t ha^{-1}
< 5
5-20
20-50
50-100
> 100
Non-Communal Farming Areas
Water
Roads
Rivers
Towns
ZAMBIA
NAMIBIA
BOTSWANA
MOZAMBIQUE
SOUTH AFRICA
Zambezi
Limpopo
Save
Victoria Falls
Hwange
Harare
Kadoma
Kwekwe
Gweru
Bulawayo
Zvishavane
Masvingo
Rusape
Mutare
0 50 100 150 200 km
Source: Grohs and Elwell (1993)
Scale 1 : 3 000 000
Projection Lambert
Central Meridian 30° E
Reference Latitude 20° S
© ISRIC 2005

Map 12. Physical suitability for rain-fed maize cultivation under low inputs and technology

The land utilization type considered in this analysis is mono-cropping, rain-fed cultivation of maize with low inputs and low technology. Cultivation practices include the use of hybrid maize. It was assumed that the crop matures in 100 days in the Middle and Lowveld and 120 days in the Highveld (lower temperatures). Farm size is generally small. Cultivation practices include manual tillage as well as animal ploughing. The latter is more important for the drier regions in the South. No, or limited, use is made of chemical fertilizers. After harvest, stubble is left for grazing or incorporated before next sowing. Sowing dates are from the second half of October until early December, and harvest is in March-April. Only one crop is grown under rain-fed conditions. Although land is under pressure from increasing population density, fallowing is still practiced; there is no continuous cropping under low-input farming.

A major part of the soils of Zimbabwe has moderate to severe limitations in nutrient availability. Therefore, a large part of the country is only marginally suitable for growing maize under low inputs (this map). This applies for all regions, Eastern Highlands, the Highveld and Middleveld to the Kalahari Sandveld. The poor fertility is generally due to very low organic carbon content, the moderately acid nature of the soils, and the often-sandy texture of the topsoil.

Limitations of soil moisture availability are more severe, but less prevalent than nutrient limitations. Soil moisture limitations are a dominant constraint for units that key out as not suitable. In the suitable areas, nutrient limitations are dominant. The moisture availability limitations occur notably in the Eastern Lowveld, and on all soils with a low rootable soil volume.

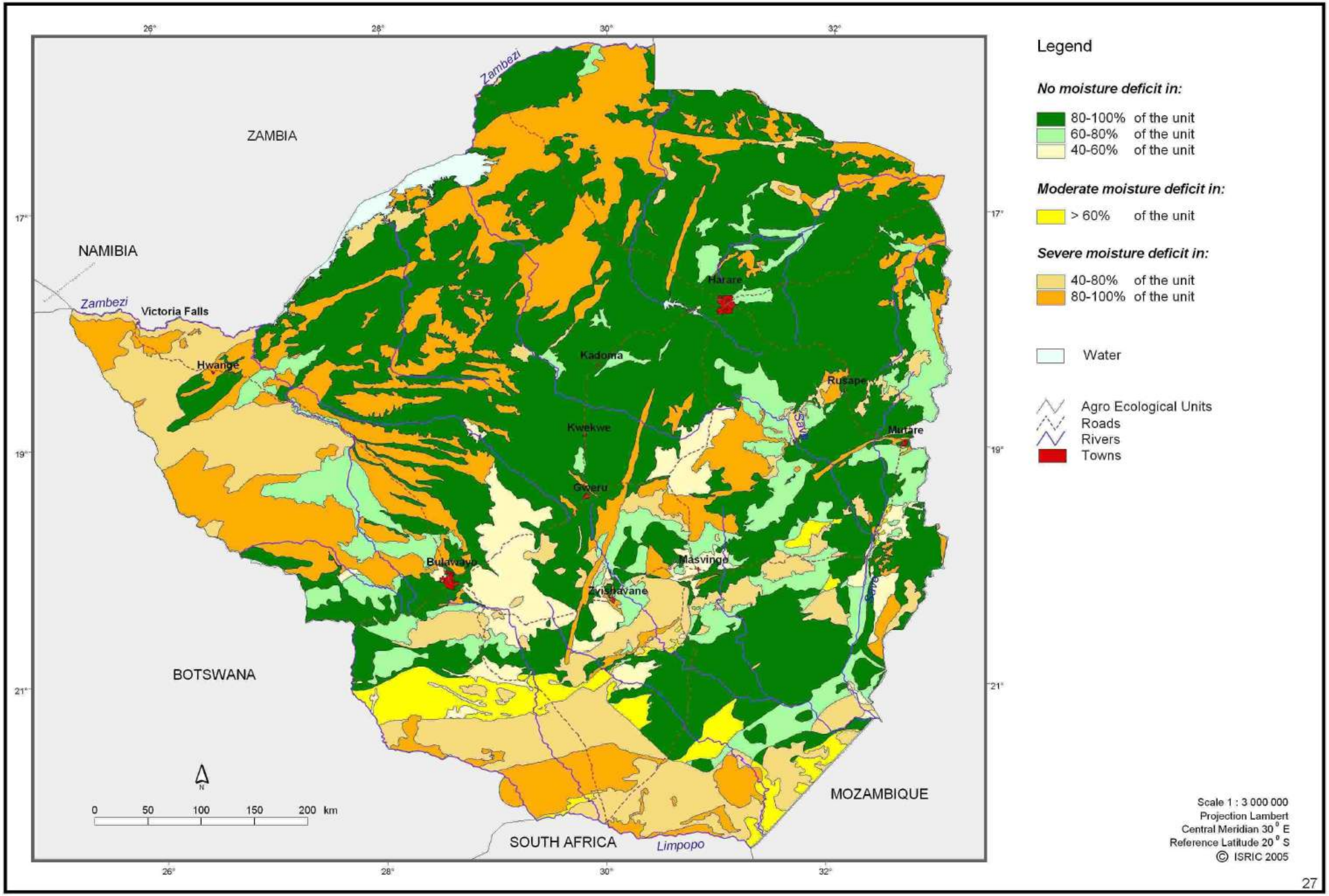


ZAMBIA
NAMIBIA
BOTSWANA
MOZAMBIQUE
SOUTH AFRICA
Zambezi
Limpopo
Save
Victoria Falls
Hwange
Harare
Kadoma
Kwekwe
Gweru
Bulawayo
Zvishavane
Masvingo
Rusape
Mutare
26°
28°
30°
32°
17°
19°
21°
0 50 100 150 200 km
N
Legend
Highly suitable
S1
Moderately suitable
S2 (moisture)*
S2 (moisture/erosion)
S2 (nutrients)
S2 (nutrients/drainage)
S2 (erosion)
S2 (drainage)
Marginally suitable
S3 (nutrients)
S3 (nutrients/rooting depth)
S3 (erosion risk)
S3 (flooding hazard)
S3 (rooting depth)
S3 (germination)
S3 (drainage)
Not suitable
N (moisture)
N (nutrients)
N (erosion)
N (rooting depth)
N (germination)
N (drainage)
N (salts)
No data
* Main limitations are shown in brackets
Water
Agro Ecological Zones
Roads
Rivers
Towns
Scale 1 : 3 000 000
Projection Lambert
Central Meridian 30° E
Reference Latitude 20° S
© ISRIC 2005

Map 13. Soil moisture availability

The availability of moisture during the growing season to rain-fed maize has been estimated using WATSAT, a simple water balance model (Mantel 1995). WATSAT runs on the basis of an interpolation of monthly rainfall and evapotranspiration averages into daily moisture gains and losses. Specific soil, crop and climatic parameters are used for the calculation of the water sufficiency, taking into account the actual rooting depth of the soil.

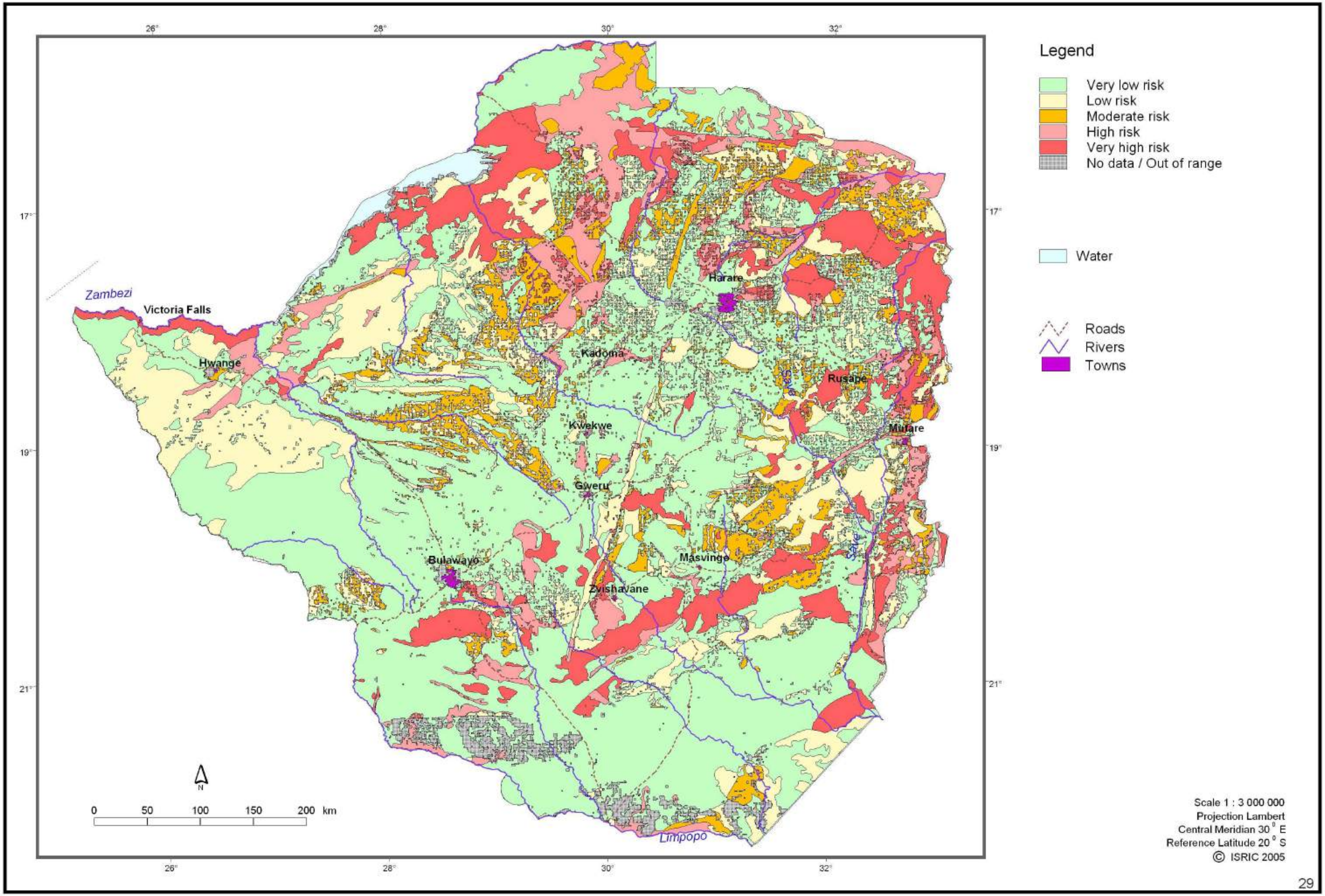
Moisture availability limitations occur notably in the Eastern Lowveld, and on all soils with a low rootable soil volume; more broadly spoken the extreme South, South-West and North.


Legend
No moisture deficit in:
80-100% of the unit
60-80% of the unit
40-60% of the unit
Moderate moisture deficit in:
> 60% of the unit
Severe moisture deficit in:
40-80% of the unit
80-100% of the unit
Water
Agro Ecological Units
Roads
Rivers
Towns
ZAMBIA
NAMIBIA
BOTSWANA
MOZAMBIQUE
SOUTH AFRICA
Zambezi
Limpopo
Save
Victoria Falls
Hwange
Harare
Kadoma
Kwekwe
Gweru
Rusape
Mutare
Bulawayo
Masvingo
Zvishavane
0 50 100 150 200 km
Scale 1 : 3 000 000
Projection Lambert
Central Meridian 30° E
Reference Latitude 20° S
© ISRIC 2005

Map 14. Water erosion risk under current land use and management

The SOTER Water Erosion Assessment Program – SWEAP (van den Berg and Tempel 1995) which uses a modified Universal Soil Loss Equation (USLE) (van den Berg and Tempel 1995; Wishmeier and Smith 1978), was used to calculate erosion risk in qualitative terms. The model has been adapted for use at the scale of the databases.

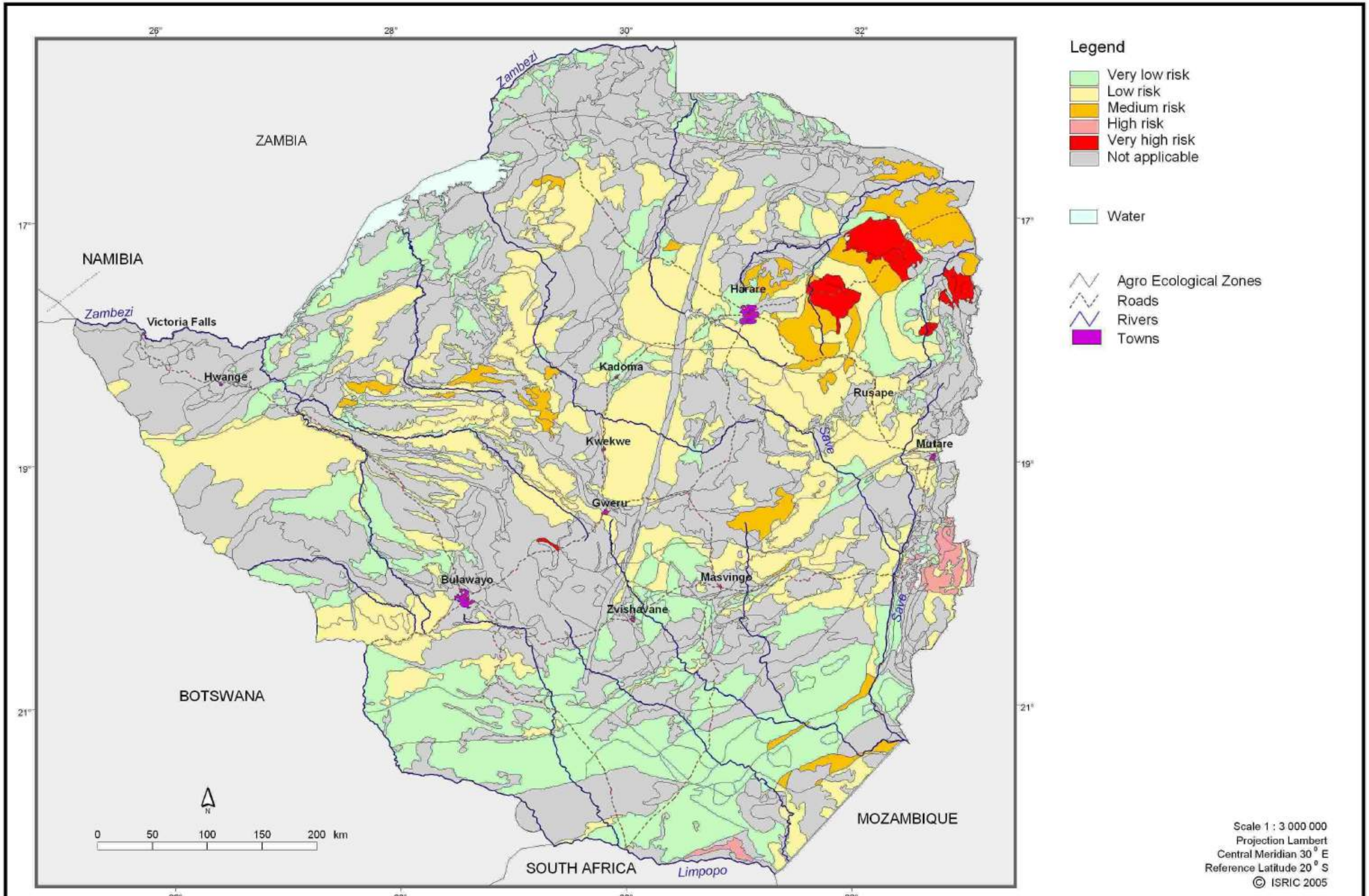
The areas with high to very high erosion risk correlate well with the steeper lands (slopes > 10%).


Legend
Very low risk
Low risk
Moderate risk
High risk
Very high risk
No data / Out of range
Water
Roads
Rivers
Towns
Zambezi
Victoria Falls
Hwange
Kadoma
Harare
Rusape
Kwekwe
Mutare
Gweru
Bulawayo
Masvingo
Zvishavane
Save
Limpopo
0 50 100 150 200 km
Scale 1 : 3 000 000
Projection Lambert
Central Meridian 30 ° E
Reference Latitude 20 ° S
© ISRIC 2005

Map 15. Water erosion risk under rain-fed maize with low inputs and technology

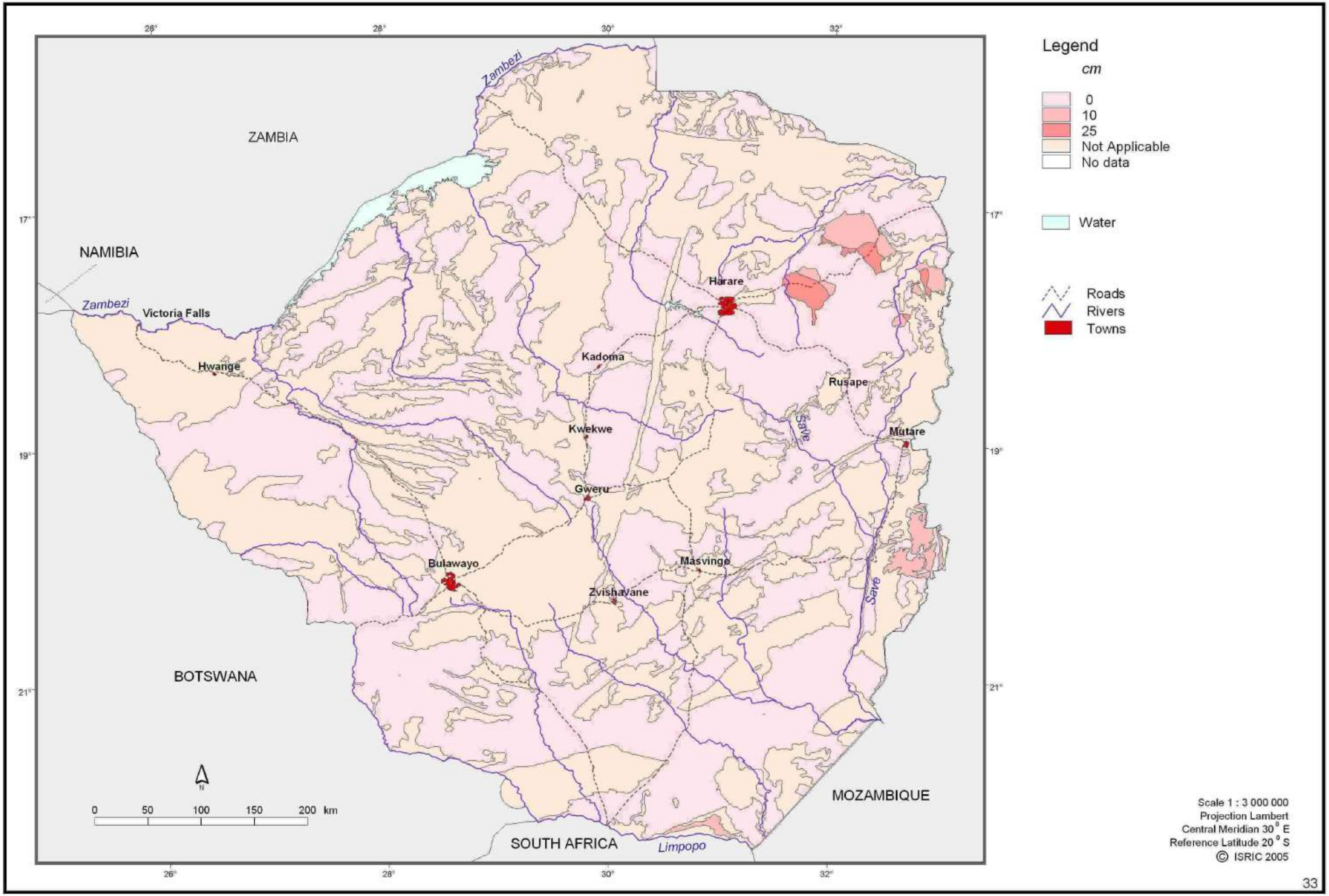
The erosion risk for all tracts of land that are considered suitable for the land use rain-fed maize with low inputs and low technology is shown on the map.

Calculations were made with the SOTER Water Erosion Assessment Program, SWEAP (van den Berg and Tempel 1995), estimating erosion risk in qualitative terms.


Legend
Very low risk
Low risk
Medium risk
High risk
Very high risk
Not applicable
Water
Agro Ecological Zones
Roads
Rivers
Towns
ZAMBIA
NAMIBIA
BOTSWANA
MOZAMBIQUE
SOUTH AFRICA
Zambezi
Limpopo
Save
Victoria Falls
Hwange
Kadoma
Harare
Rusape
Kwekwe
Mutare
Gweru
Bulawayo
Masvingo
Zvishavane
26°
28°
30°
32°
17°
19°
21°
N
0
50
100
150
200 km
Scale 1 : 3 000 000
Projection Lambert
Central Meridian 30° E
Reference Latitude 20° S
© ISRIC 2005

Map 16. Projected loss of topsoil after 20 years of soil erosion

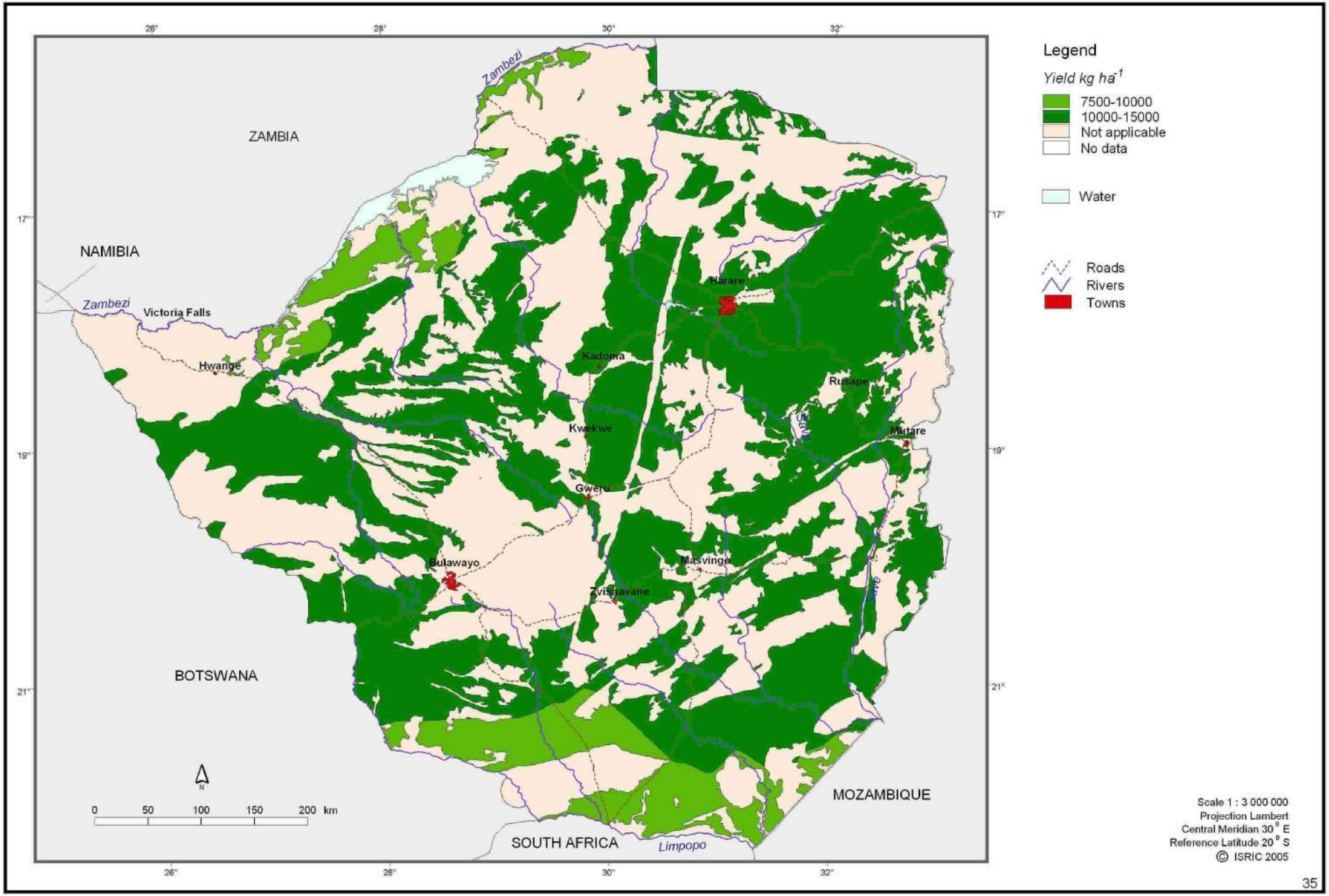
Projected soil losses obtained with the SWEAP model (van den Berg and Tempel 1995) were multiplied by the number of scenario years (20) and re-calculated to volume per unit area. The values then represent cm of soil lost and these figures were classified to 4 classes of projected topsoil loss.


Legend
cm
0
10
25
Not Applicable
No data
Water
Roads
Rivers
Towns
ZAMBIA
NAMIBIA
BOTSWANA
MOZAMBIQUE
SOUTH AFRICA
Zambezi
Limpopo
Save
Victoria Falls
Hwange
Harare
Kadoma
Kwekwe
Gweru
Rusape
Mutare
Bulawayo
Masvingo
Zvishavane
0 50 100 150 200 km
Scale 1 : 3 000 000
Projection Lambert
Central Meridian 30° E
Reference Latitude 20° S
© ISRIC 2005

Map 17. Constraint-free maize yield

The potential maize yield under the prevailing agro-ecological conditions (soil, climate) was calculated using the crop growth simulation model WOFOST (van Diepen *et al.* 1989; van Diepen *et al.* 1991; van Keulen and Wolf 1986). The model calculates crop yields for three principal growth constraints: constraint-free (this map); potential water-limited (map 18); and potential nutrient-limited maize yield (map 20).

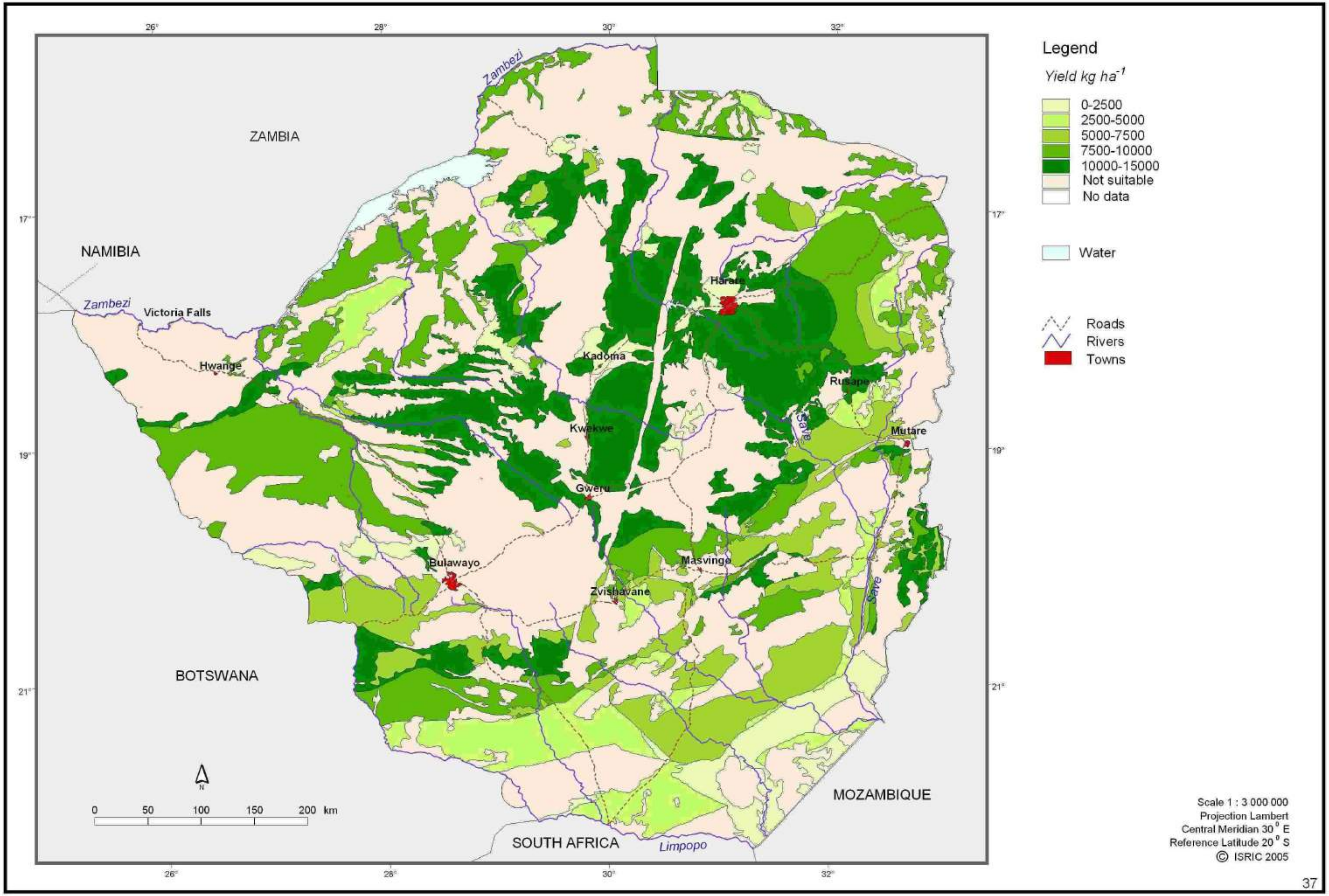
The constraint-free yield is the bio-physical production ceiling: the maximum production attainable when moisture, nutrients, weeds and pests are not limiting, and crop production is influenced only by solar radiation (cloudiness) and temperature.


Legend
Yield kg ha-1
7500-10000
10000-15000
Not applicable
No data
Water
Roads
Rivers
Towns
ZAMBIA
NAMIBIA
BOTSWANA
MOZAMBIQUE
SOUTH AFRICA
Zambezi
Limpopo
Save
Victoria Falls
Hwange
Harare
Kadoma
Kwekwe
Gweru
Rusape
Mutare
Bulawayo
Masvingo
Zvishavane
26°
28°
30°
32°
17°
19°
21°
0 50 100 150 200 km
N
Scale 1 : 3 000 000
Projection Lambert
Central Meridian 30° E
Reference Latitude 20° S
© ISRIC 2005

Map 18. Potential water-limited maize yield

Water-limited yield refers to the potential crop production as constrained only by water availability to the plants.

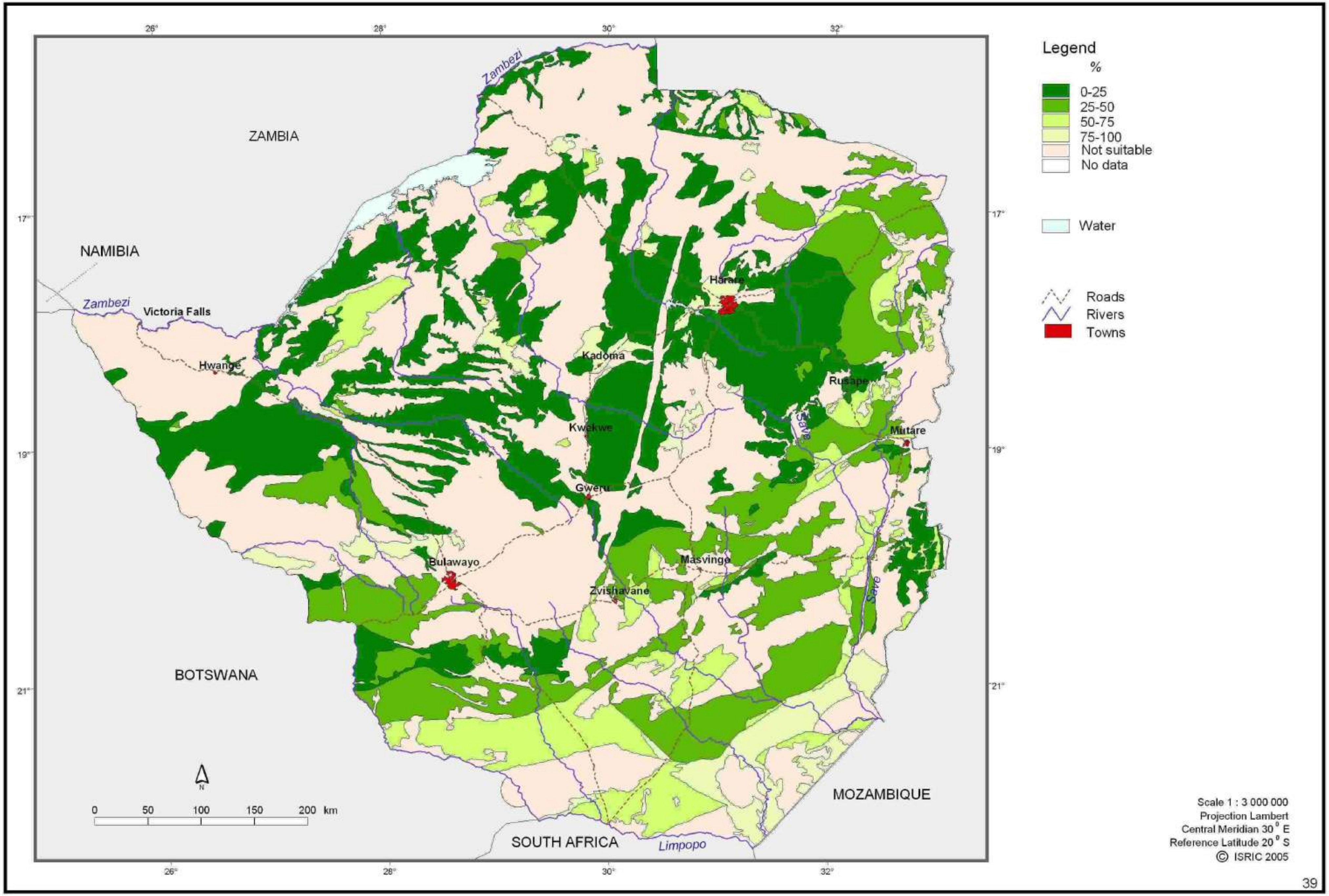
Water-limited yields are high, in some areas close to the constraint-free yield under the assumption of unrestricted rooting depth. Broadly speaking, water-limited yield gaps increase to the southeast (AEZ V-4/5, Map 1), where moisture conditions are constraining. This study used averaged climate data that were manipulated using a rainfall generator, so as to simulate rainfall distributions. Therefore, extreme dry and wet years were not considered in the analysis. Yet, the droughts recurring with an interval of several years and related to El Niño, Southern Oscillation (ENSO), will adversely affect yields and food security.


Legend
Yield kg ha-1
0-2500
2500-5000
5000-7500
7500-10000
10000-15000
Not suitable
No data
Water
Roads
Rivers
Towns
ZAMBIA
NAMIBIA
BOTSWANA
MOZAMBIQUE
SOUTH AFRICA
Zambezi
Limpopo
Save
Victoria Falls
Hwange
Harare
Kadoma
Kwekwe
Gweru
Rusape
Mutare
Bulawayo
Masvingo
Zvishavane
26°
28°
30°
32°
17°
19°
21°
0 50 100 150 200 km
N
Scale 1 : 3 000 000
Projection Lambert
Central Meridian 30° E
Reference Latitude 20° S
© ISRIC 2005

Map 19. Potential water-limited maize yield gap

The water-limited maize yield gap is defined as the difference between water-limited yield and constraint-free yield, expressed in percent of constraint-free yield.

The central part of Zimbabwe, around the Great Dike, has a water-limited yield potential that is close to optimum; 27% of the total *suitable* area. The area bordering the central core has a high water-limited yield potential, between 7.5 t ha^{-1} to 10 t ha^{-1} (28% of the total *suitable* area). To the southeast, the water-limited yield potential decreases from 5 to 7.5 t ha^{-1} (21%) to 2.5 to 5 t ha^{-1} (14%) and even lower (9% of the total *suitable* area). This map shows that in the extreme southeast (AEZ V-4/5, Map 1) moisture conditions are below optimal, leading to water-limited yield gaps (difference between water-limited yield and constraint-free yield expressed in % of constraint-free yield) of over 75%, meaning that water-limited yield is 25% or less relative to the constraint-free yield. Other areas that have high yield gaps (>75%) include the agro-ecological units north of the cities Harare, Bulawayo, Kadora, and East of Kwekwe.

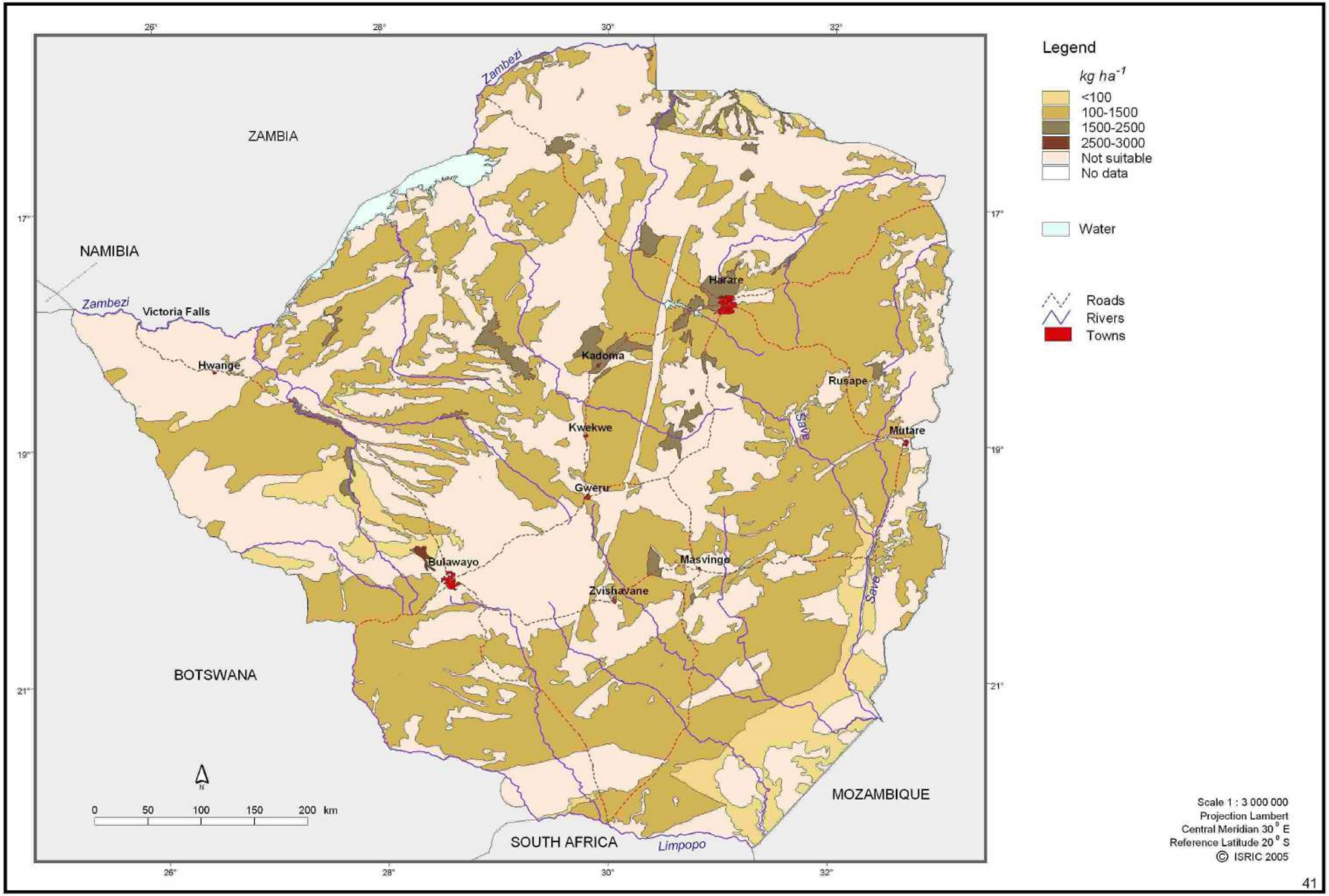


26°
28°
30°
32°
17°
19°
21°
ZAMBIA
NAMIBIA
BOTSWANA
MOZAMBIQUE
SOUTH AFRICA
Zambezi
Limpopo
Save
Victoria Falls
Hwange
Harare
Kadoma
Rusape
Kwekwe
Mutare
Gweru
Bulawayo
Masvingo
Zvishavane
N
0 50 100 150 200 km
Legend
%
0-25
25-50
50-75
75-100
Not suitable
No data
Water
Roads
Rivers
Towns
Scale 1 : 3 000 000
Projection Lambert
Central Meridian 30 ° E
Reference Latitude 20 ° S
© ISRIC 2005

Map 20. Potential nutrient-limited maize yield

The potential nutrient-limited yield - defined as the potential production or yield, limited by availability of soil nutrients - is calculated in WOFOST with a sub-module based on the QUEFTS model (Janssen *et al.* 1990).

In Zimbabwe, paucity of crop nutrients is the major limitation in subsistence agriculture. Nutrient-limited yield potentials are all low for maize grown under rain-fed conditions and with low inputs. Most of Zimbabwe has a nutrient-limited yield potential less than 1.5 t ha^{-1}. In the extreme north, southeast, and southwest, nutrient-limited yields are even below 0.5 t ha^{-1}. Phosphorus is the most limiting nutrient (dominantly below 10 kg extractable P_2O_5 ha^{-1} and often even less than 5 kg P_2O_5 ha^{-1}); nitrogen is also consistently low for most Zimbabwean soils (from 10 to 146 kg ha^{-1}).

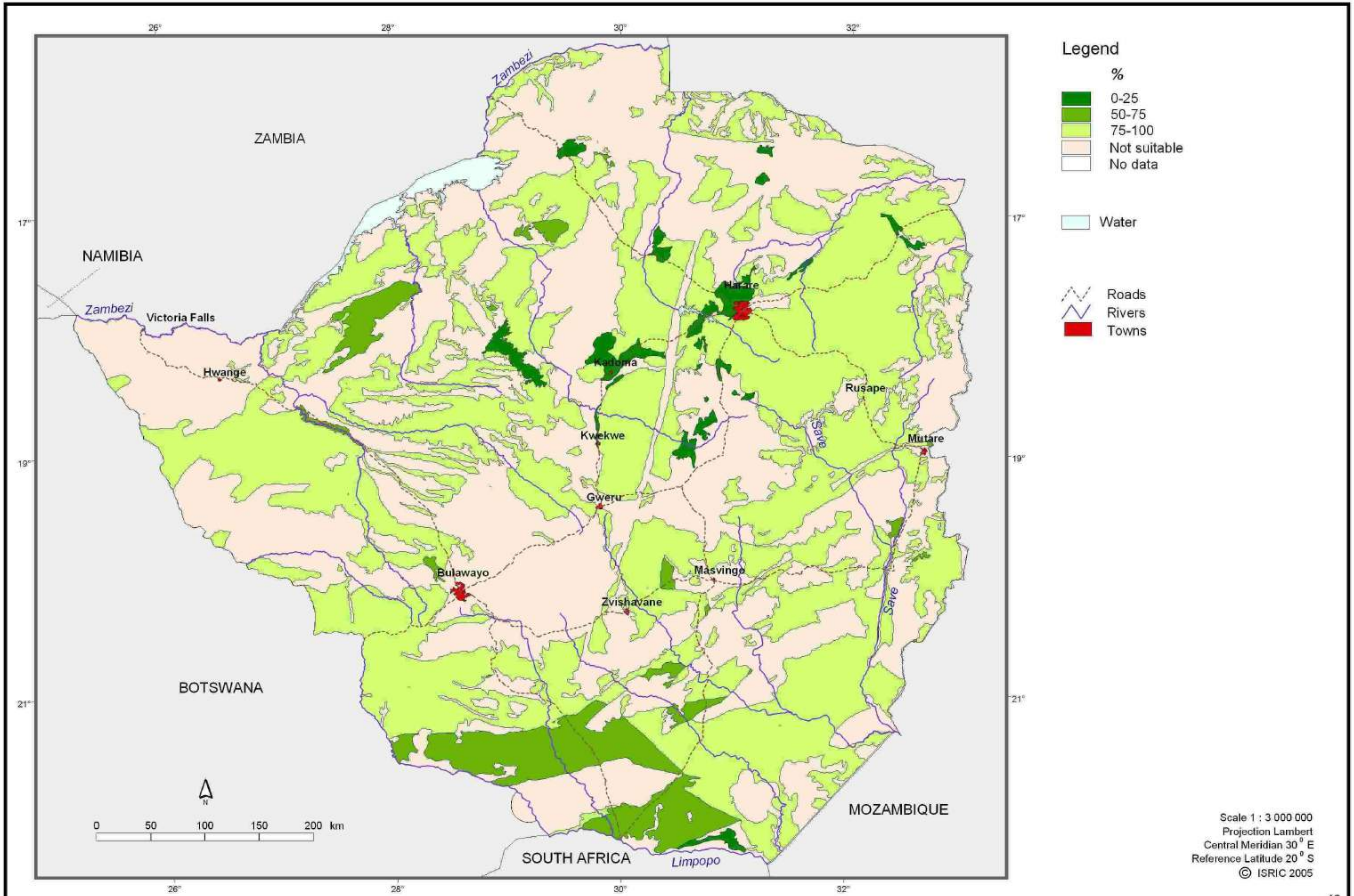


Legend
kg ha^{-1}
<100
100-1500
1500-2500
2500-3000
Not suitable
No data
Water
Roads
Rivers
Towns
ZAMBIA
NAMIBIA
BOTSWANA
MOZAMBIQUE
SOUTH AFRICA
Zambezi
Limpopo
Save
Victoria Falls
Hwange
Kadoma
Harare
Rusape
Kwekwe
Mutare
Gweru
Bulawayo
Masvingo
Zvishavane
26°
28°
30°
32°
17°
19°
21°
0 50 100 150 200 km
Scale 1 : 3 000 000
Projection Lambert
Central Meridian 30° E
Reference Latitude 20° S
© ISRIC 2005

Map 21. Potential nutrient-limited maize yield gap relative to potential water-limited yield

This map shows the nutrient-limited yield gap with potential water-limited yield, which can be considered the maximum attainable yield for rain-fed maize under low levels of input and technology.

Nutrient-limited maize yields are extremely low for the whole of Zimbabwe, when no input is assumed, due to low inherent soil fertility. This analysis shows that nutrients are the overriding constraint to low input farming.

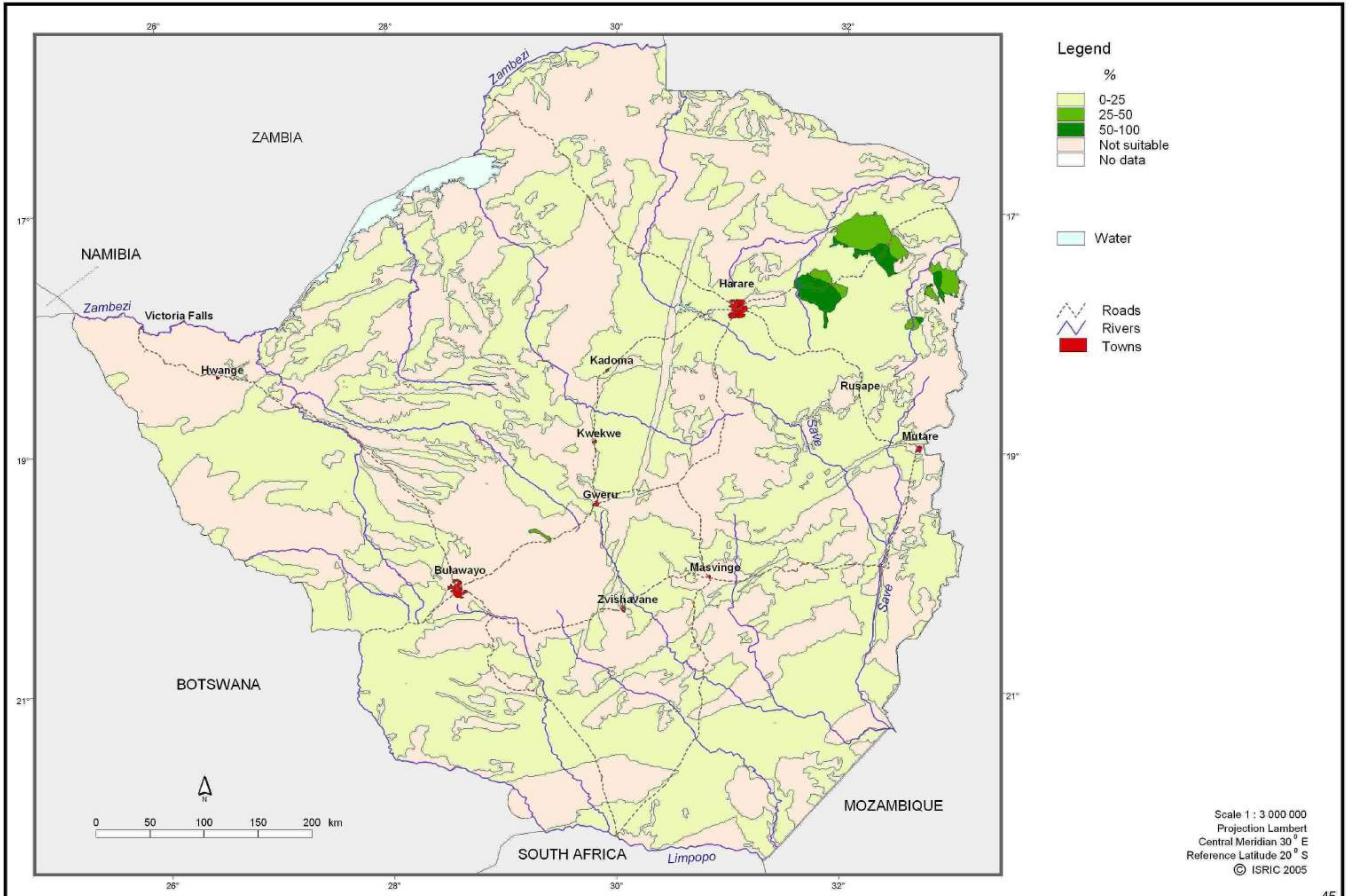


Legend
%
0-25
50-75
75-100
Not suitable
No data
Water
Roads
Rivers
Towns
ZAMBIA
NAMIBIA
BOTSWANA
MOZAMBIQUE
SOUTH AFRICA
Zambezi
Limpopo
Save
Victoria Falls
Hwange
Harare
Kadoma
Kwekwe
Gweru
Bulawayo
Zvishavane
Masvingo
Rusape
Mutare
0 50 100 150 200 km
Scale 1 : 3 000 000
Projection Lambert
Central Meridian 30 ° E
Reference Latitude 20 ° S
© ISRIC 2005

Map 22. Projected nutrient-limited maize yield decline after 20 years of soil erosion

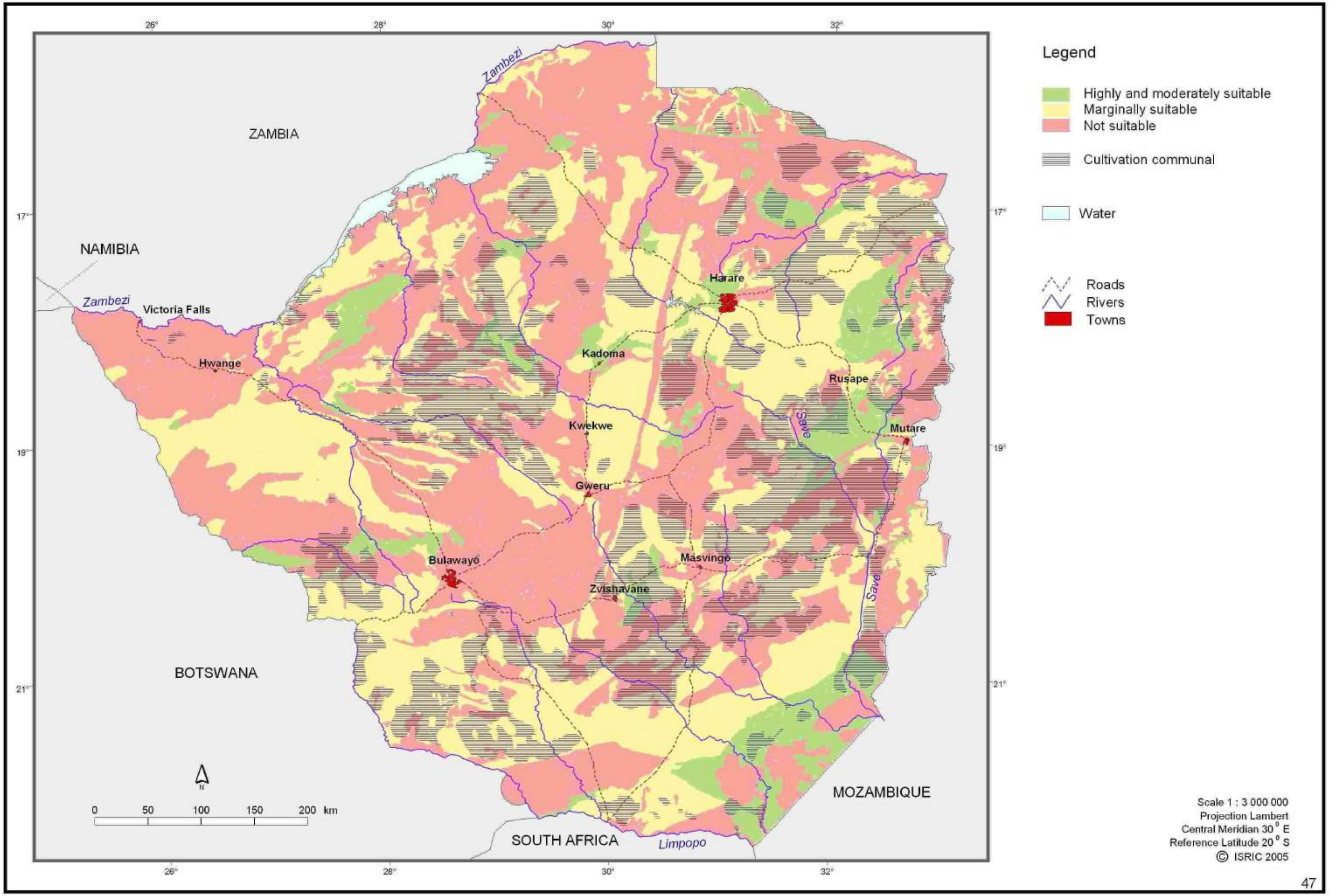
The map shows the decrease of the calculated nutrient-limited yield going from the current situation to a scenario of prolonged topsoil erosion over 20 years. (as defined in Mantel & van Engelen, 1999)

A high yield impact is predicted for only 3% of the total *suitable* area.


26°
28°
30°
32°
17°
19°
21°
ZAMBIA
NAMIBIA
BOTSWANA
SOUTH AFRICA
MOZAMBIQUE
Zambezi
Limpopo
Save
Victoria Falls
Hwange
Kadoma
Harare
Rusape
Kwekwe
Mutare
Gweru
Bulawayo
Masvingo
Zvishavane
0 50 100 150 200 km
N
Legend
%
0-25
25-50
50-100
Not suitable
No data
Water
Roads
Rivers
Towns
Scale 1 : 3 000 000
Projection Lambert
Central Meridian 30° E
Reference Latitude 20° S
© ISRIC 2005

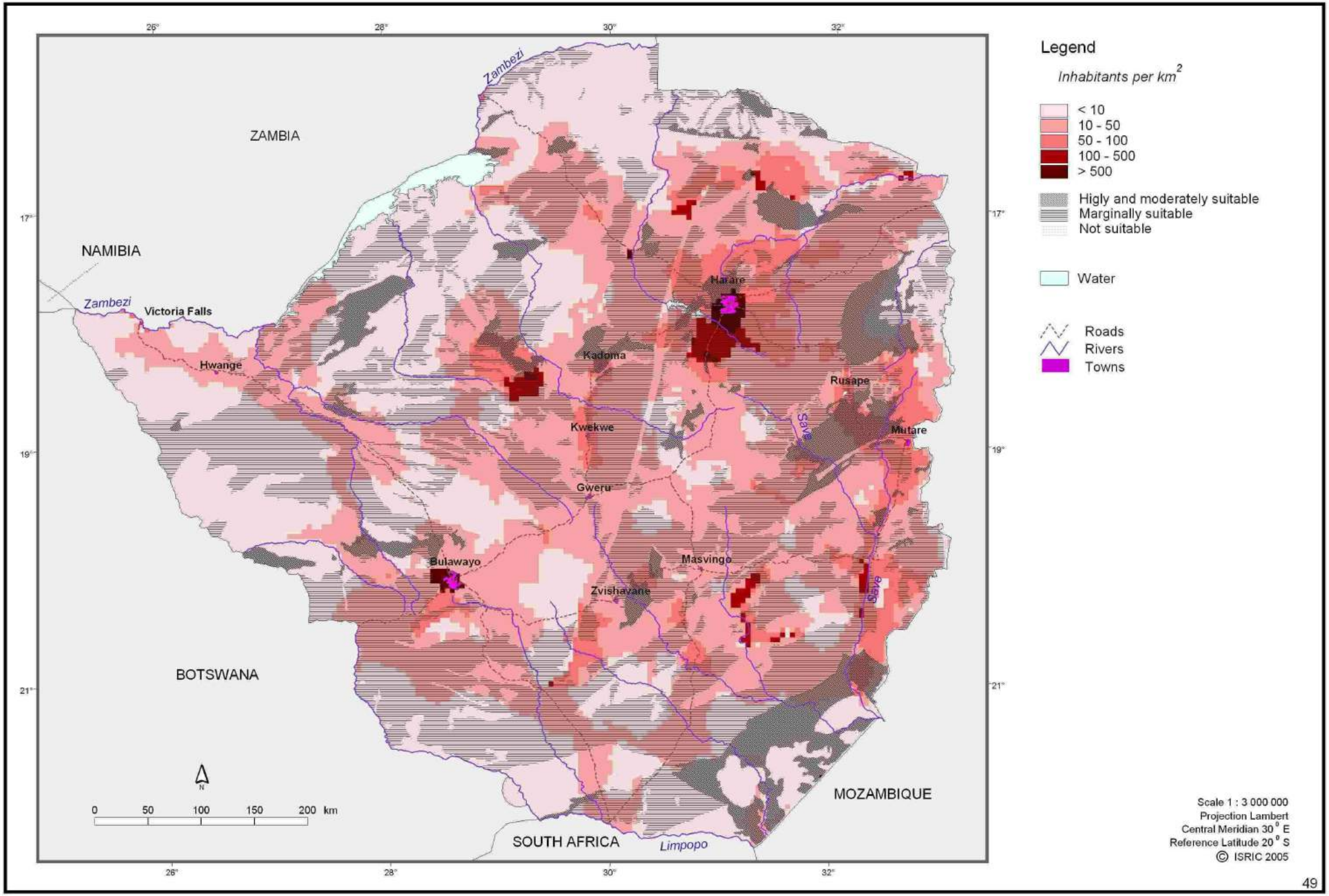
Map 23. Cultivated areas in the Communal Lands and suitability for rain-fed maize (low inputs and technology)

This map shows the cultivated areas in the Communal Lands together with the land suitability for rain-fed maize (low input and technology). There is a clear overlap between Communal Lands and areas considered unsuitable for cultivation under sustainable practices.


Legend
Highly and moderately suitable
Marginally suitable
Not suitable
Cultivation communal
Water
Roads
Rivers
Towns
ZAMBIA
NAMIBIA
BOTSWANA
MOZAMBIQUE
SOUTH AFRICA
Zambezi
Limpopo
Save
Victoria Falls
Hwange
Kadoma
Harare
Rusape
Mutare
Kwekwe
Gweru
Bulawayo
Masvingo
Zvishavane
0 50 100 150 200 km
Scale 1 : 3 000 000
Projection Lambert
Central Meridian 30° E
Reference Latitude 20° S
© ISRIC 2005

Map 24. Population density and suitability for rain-fed maize (low inputs and technology)

This map shows the population density and the suitability for rain-fed maize (low inputs and technology); many people are living on marginal lands.


Legend
Inhabitants per km²
< 10
10 - 50
50 - 100
100 - 500
> 500
Higly and moderately suitable
Marginally suitable
Not suitable
Water
Roads
Rivers
Towns
ZAMBIA
NAMIBIA
BOTSWANA
MOZAMBIQUE
SOUTH AFRICA
Zambezi
Limpopo
Save
Victoria Falls
Hwange
Harare
Kadoma
Kwekwe
Rusape
Mutare
Gweru
Bulawayo
Masvingo
Zvishavane
0 50 100 150 200 km
Scale 1 : 3 000 000
Projection Lambert
Central Meridian 30° E
Reference Latitude 20° S
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