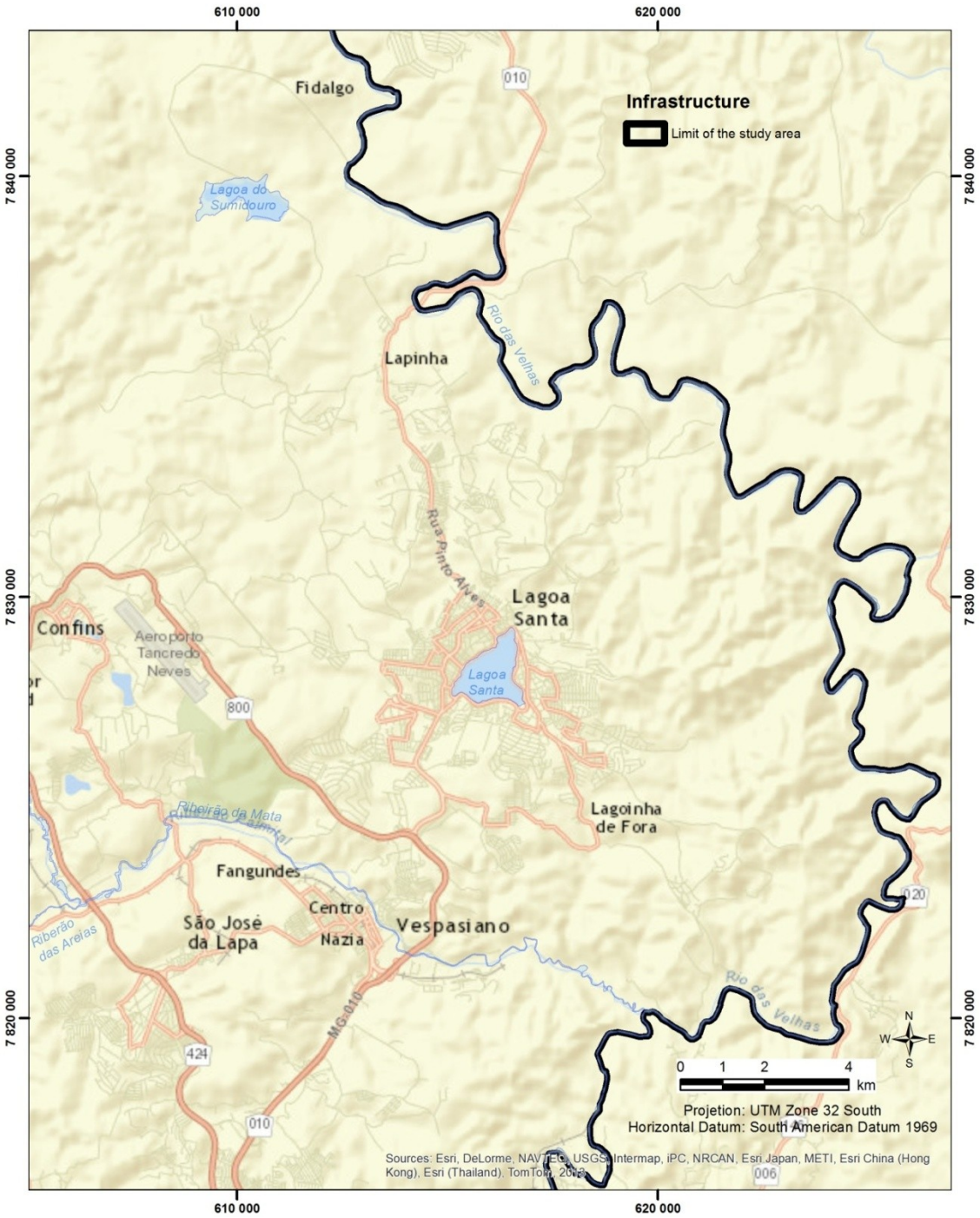
Annex II: Maps of geo-potentials

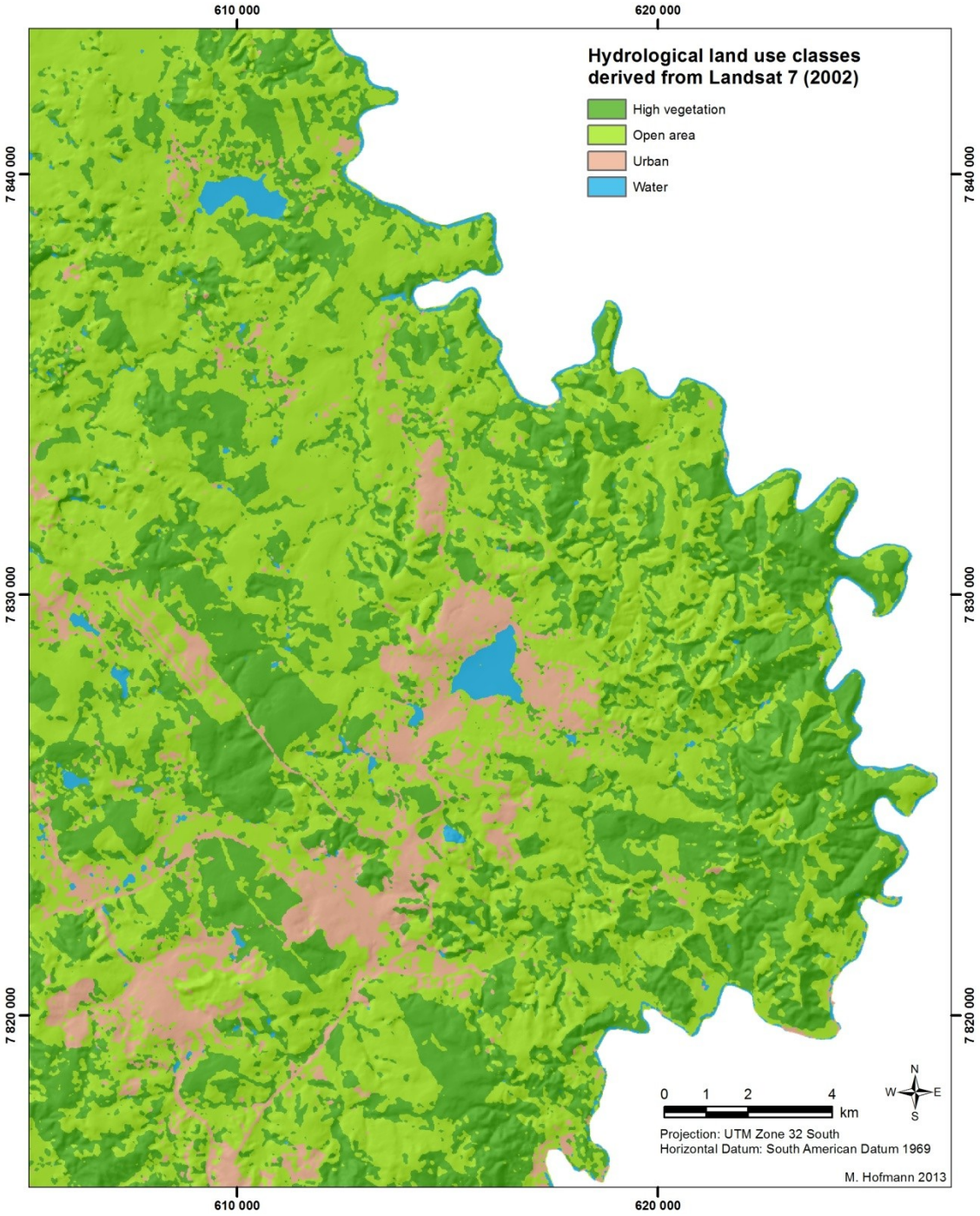
A. General base data

1. Infrastructure



Map 1 Infrastructure

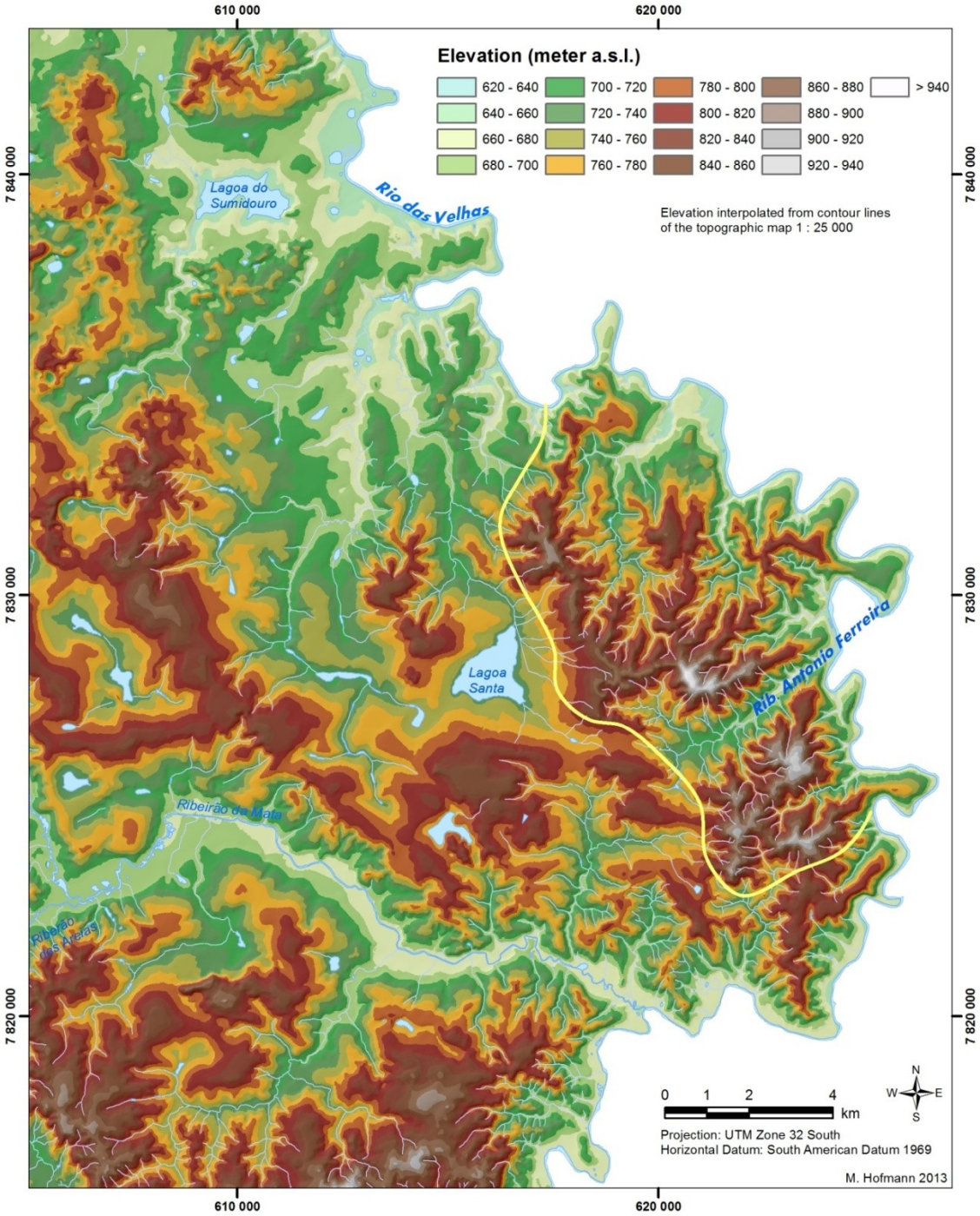
2. Landuse



Map 2 Land use

Classified image from Landsat 7 Landsat ETM+ image from 03.August 2002.

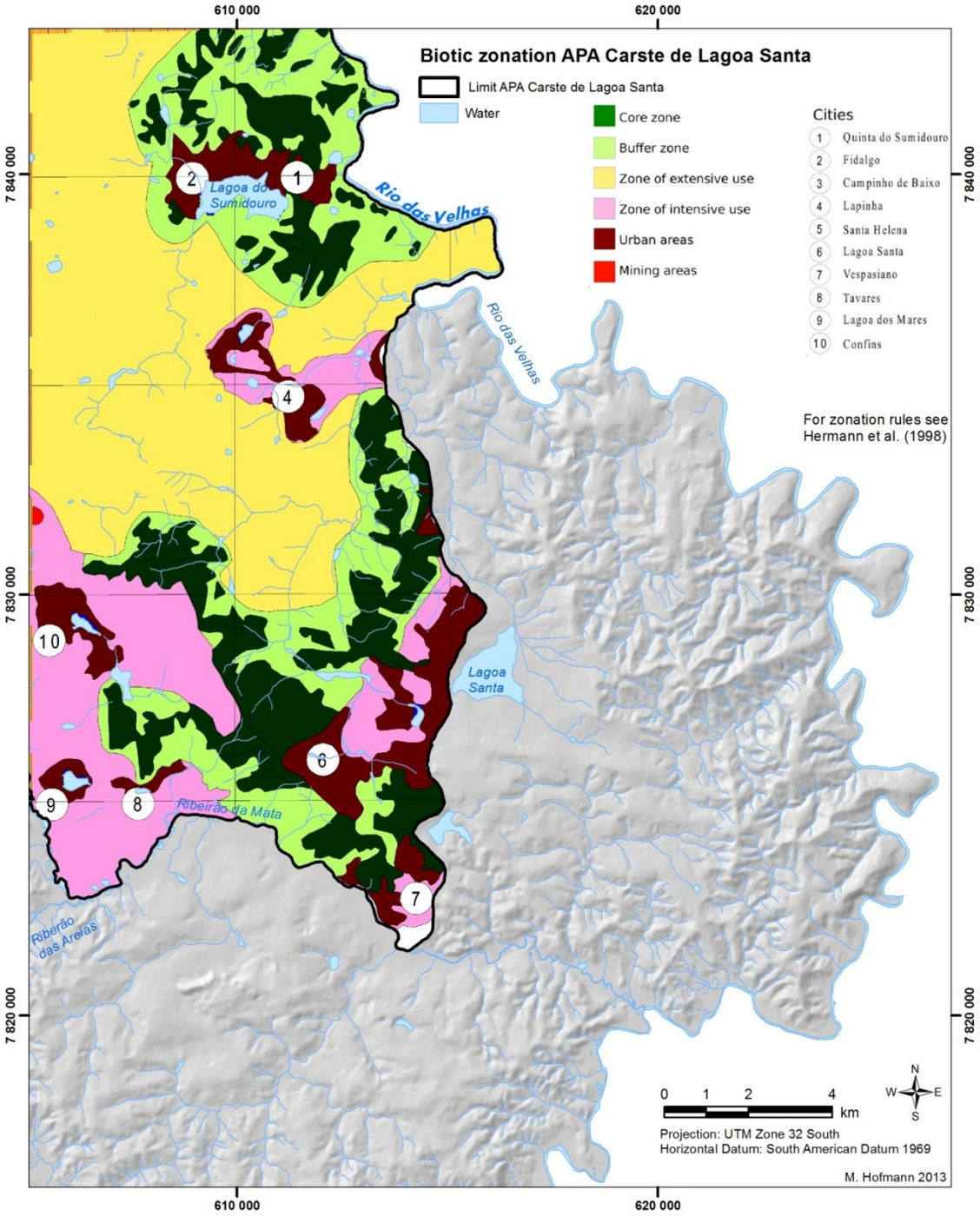
3. Topography



Map 3 Relief of the study area

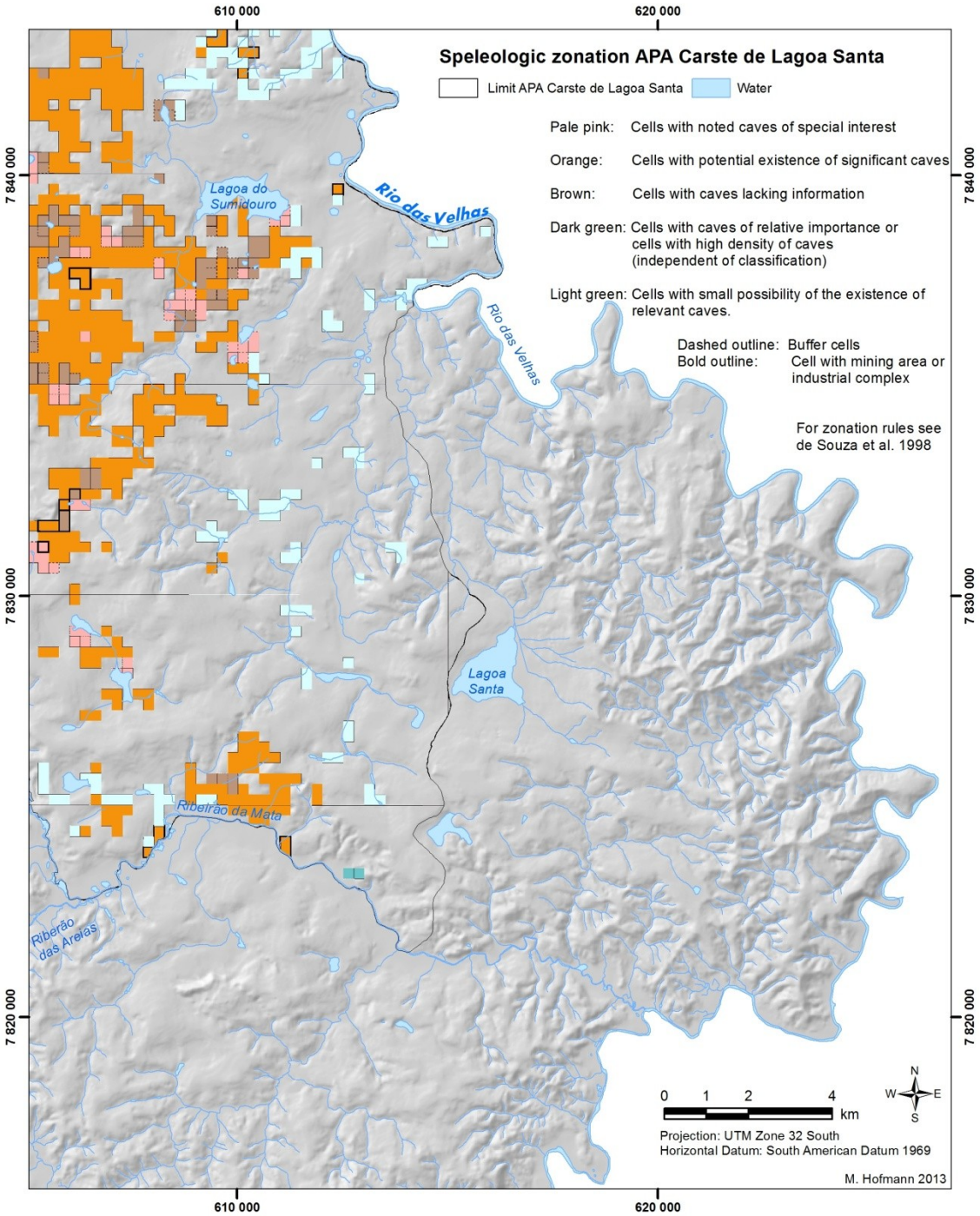
The map is based on contour lines from the topographic map 1 : 25 000. Remnants of plateau surfaces are dissected by streams and declining from SSW to NNW. In the north-west, the karstified limestone crops out. Exceptional to this regional trend are the steeper and higher hills east of the triangular Lake Lagoa Santa (yellow line).

4. Zonation from APA Carste de Lagoa Santa



Map 4 Biotic zonation APA Carste de Lagoa Santa.

Biotic zonation for the environmental protection area APA Carste de Lagoa Santa. Source: Hermann et al. (1998)

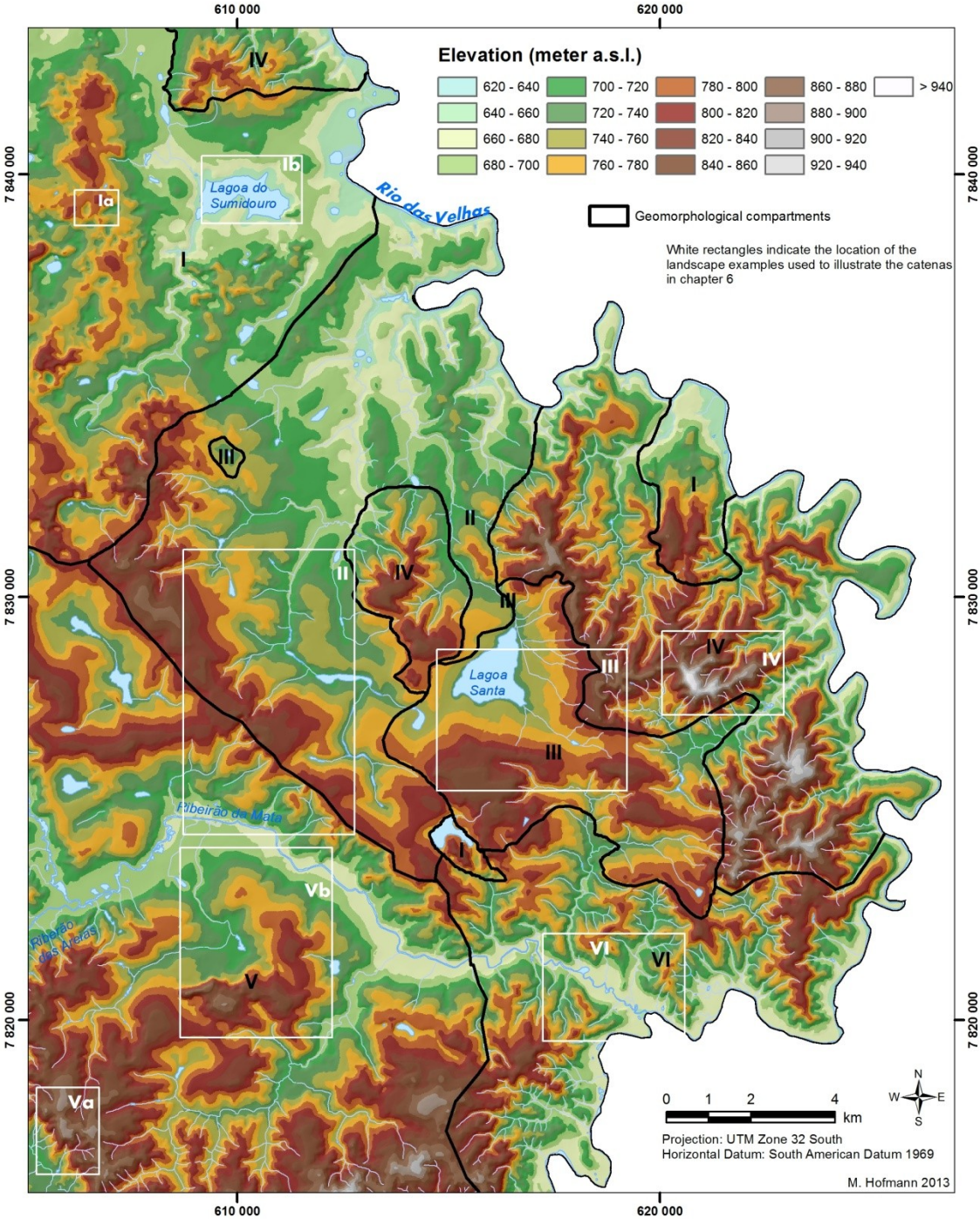


Map 5 Speleological zonation

Speleological zonation in the environmental protection area APA Carste de Lagoa Santa. Source: de Souza et al. (1998).

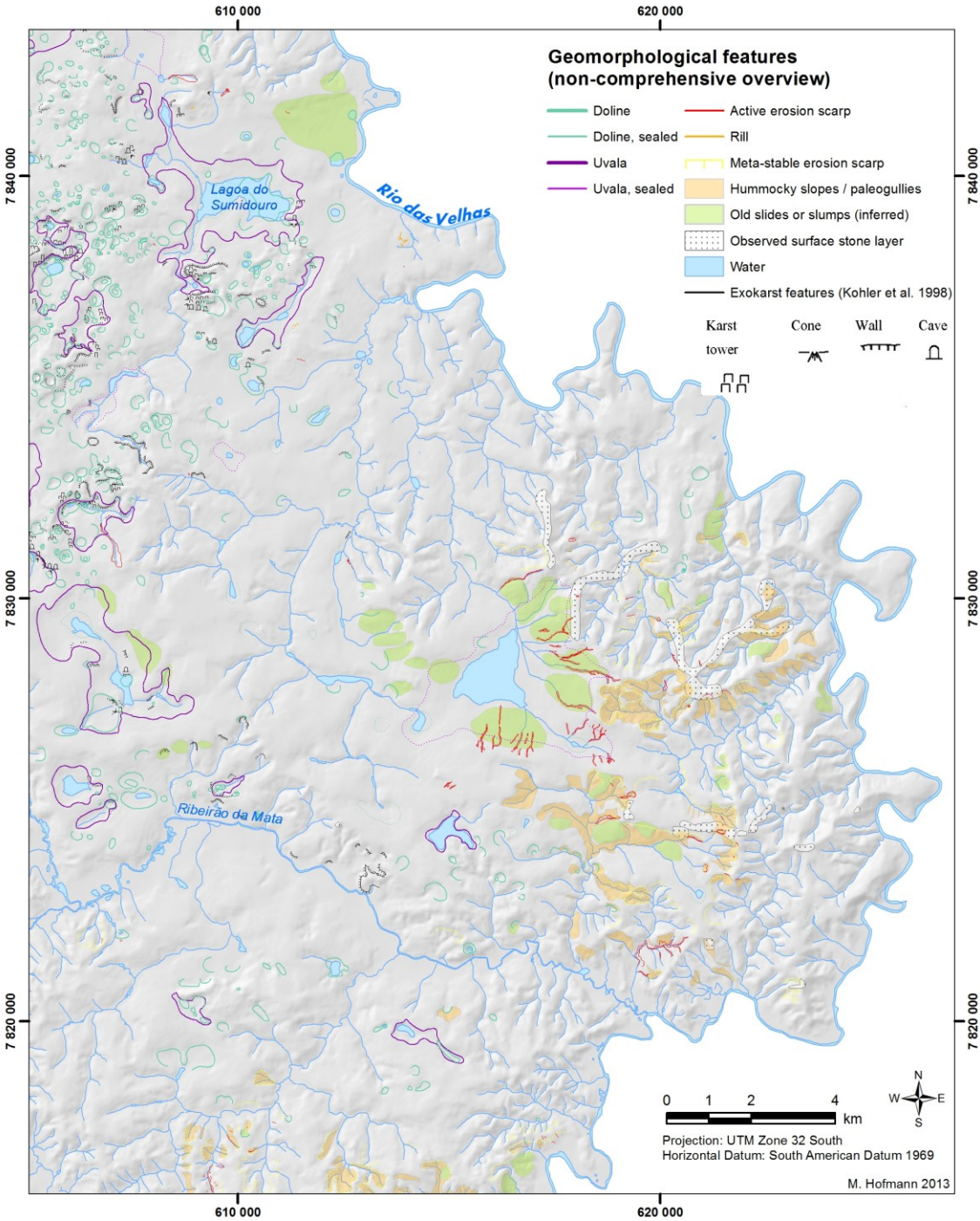
B. Relief and geomorphology

1. Geomorphology



Map 6 Geomorphological compartments

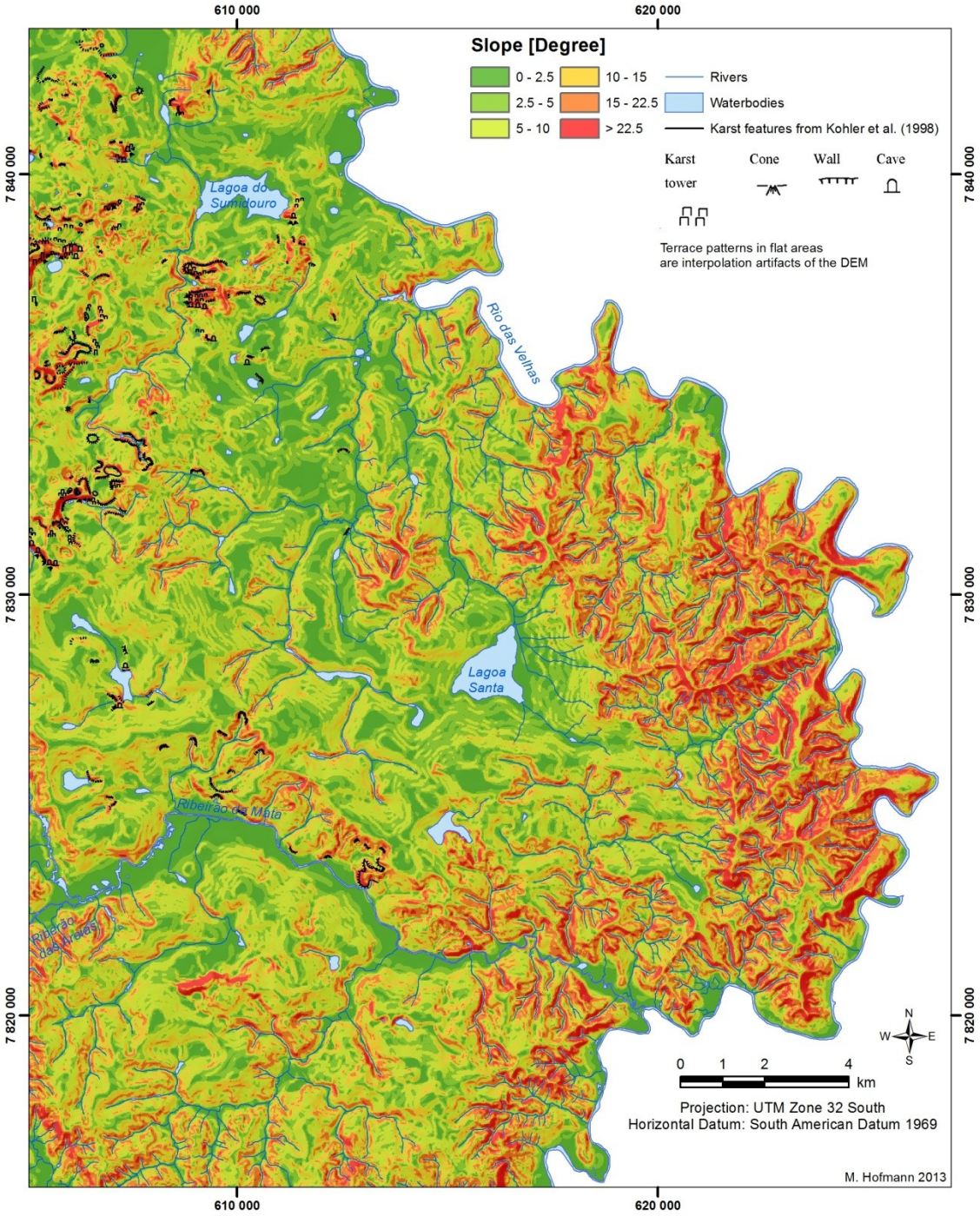
Compartments as described in section 6.5 (black lines) and locations of satellite images and mapped topographic position indices used to illustrate the catenas (white rectangles).



Map 7 Geomorphological features

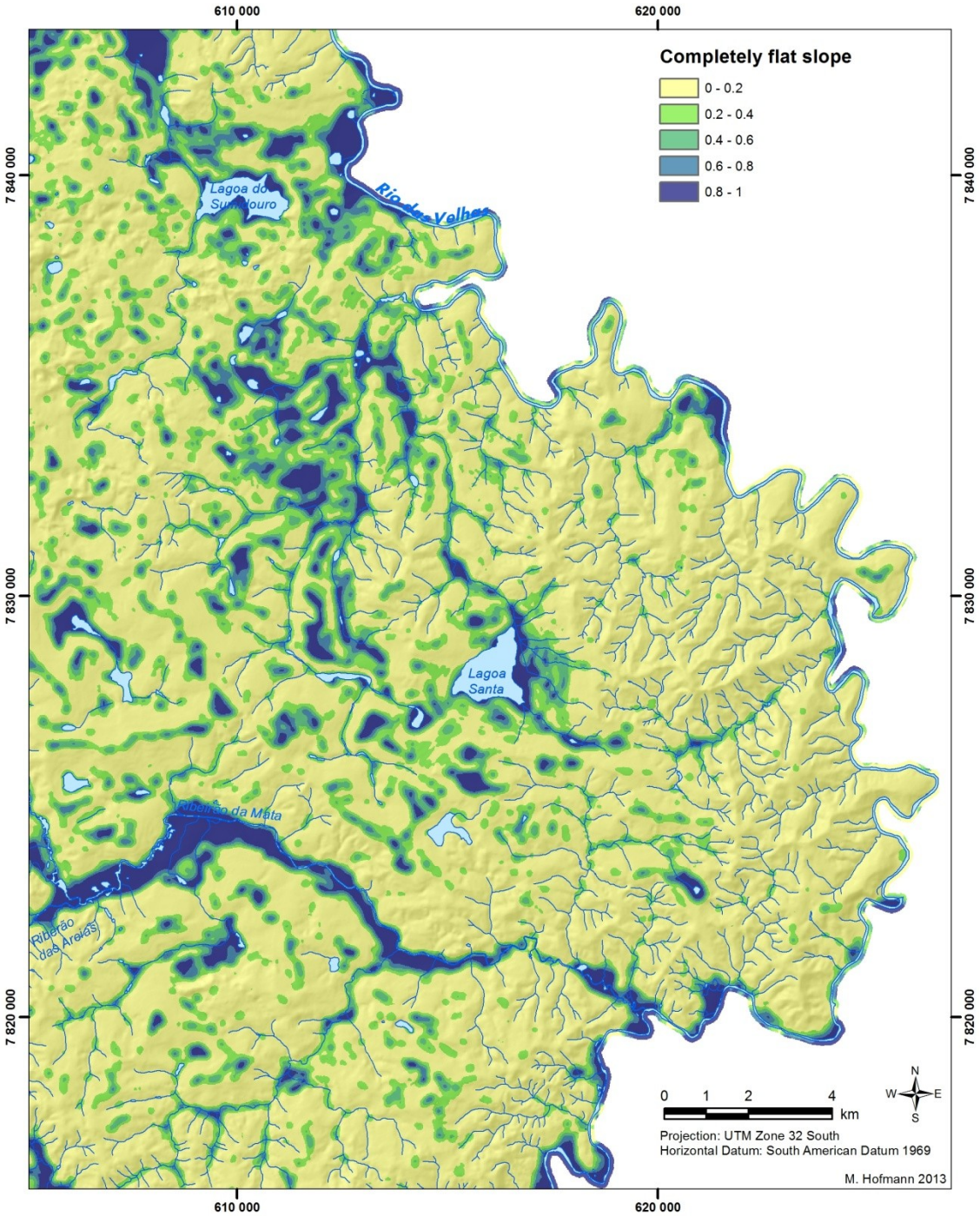
Data from Kohler et al. (1998) supplemented by features identified from relief data and on images from Google Earth (non-comprehensive overview).

2. Slope



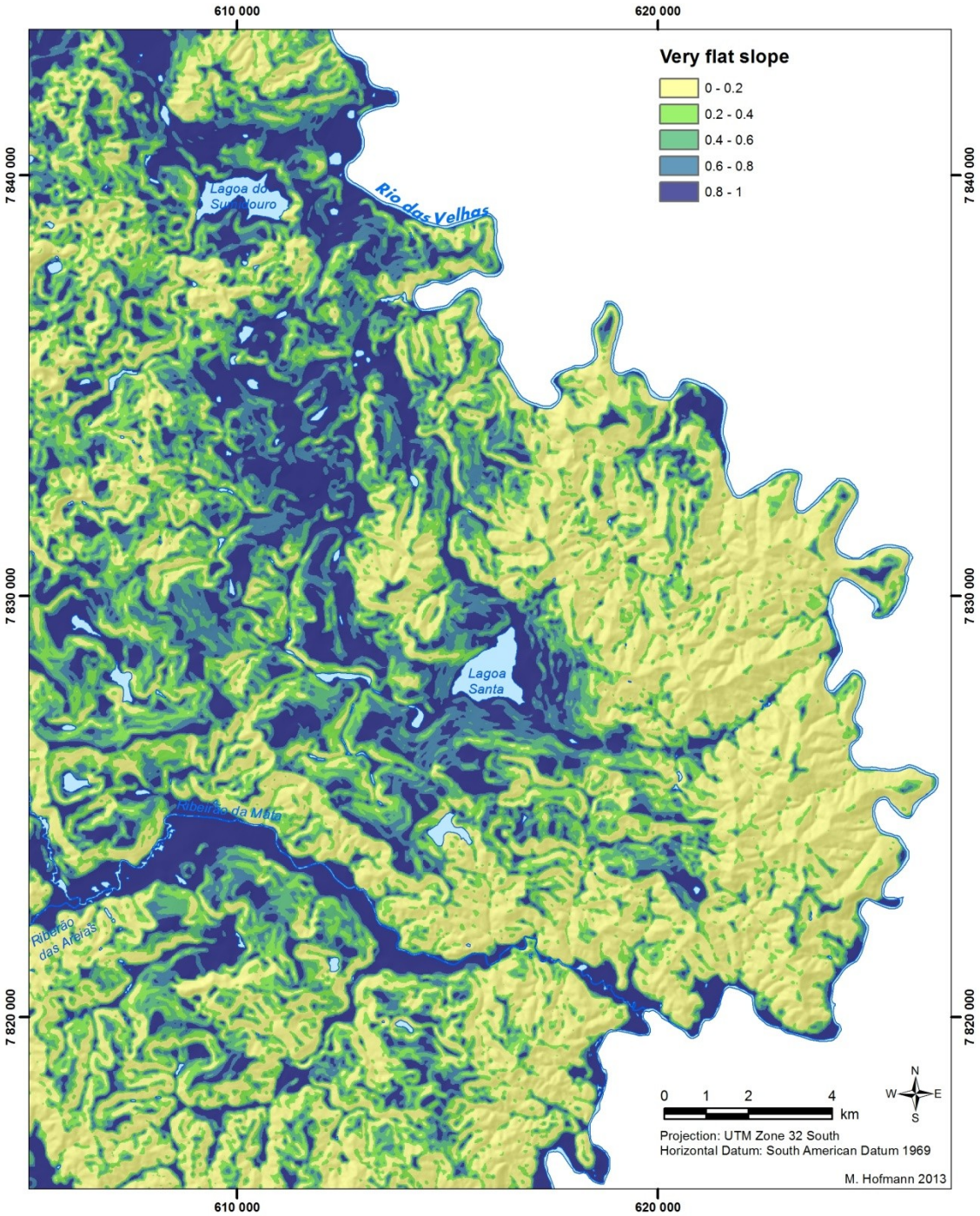
Map 8 Slope (Degree)

See also section 10.3.2



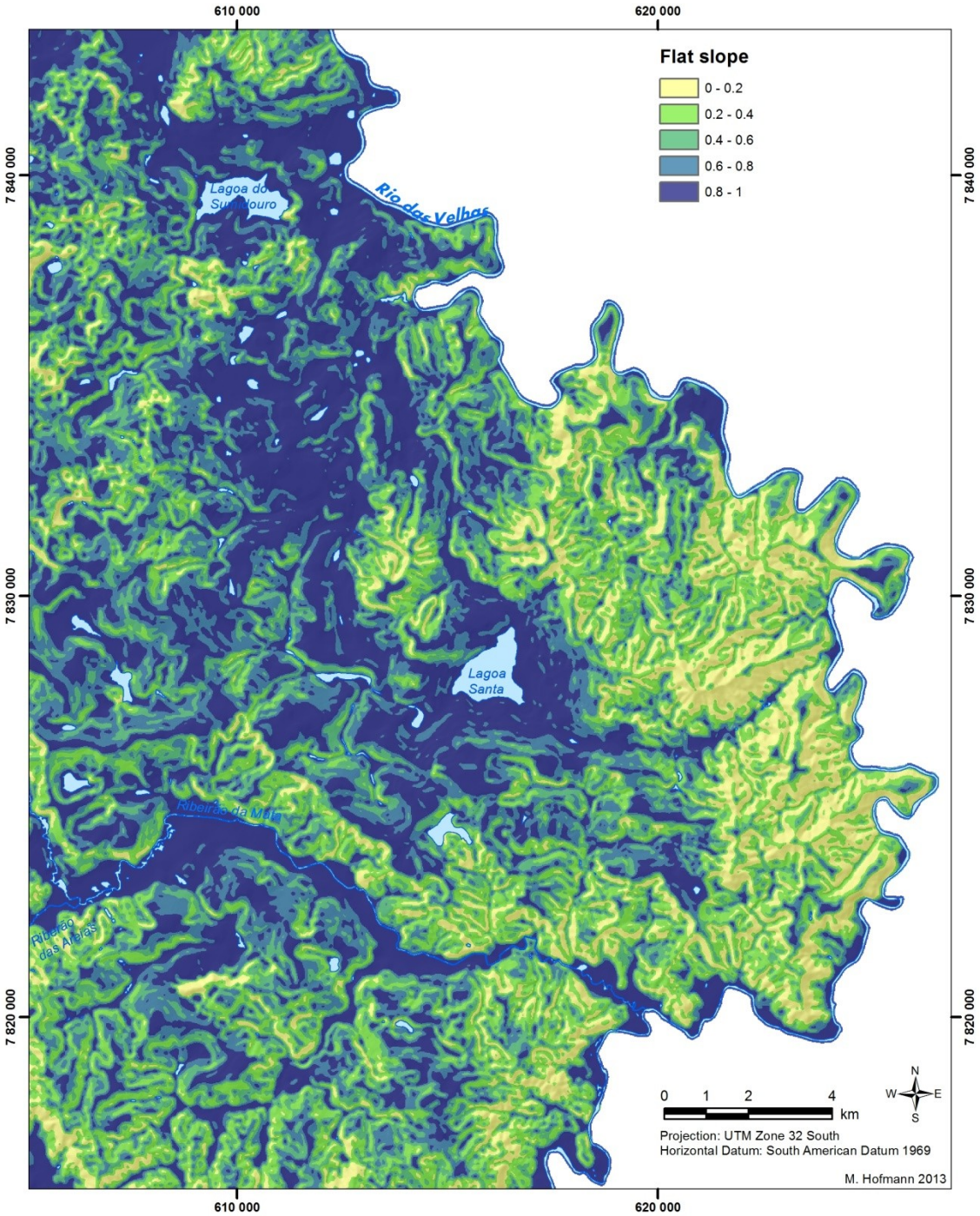
Map 9 Completely flat slope

See also section 10.3.2



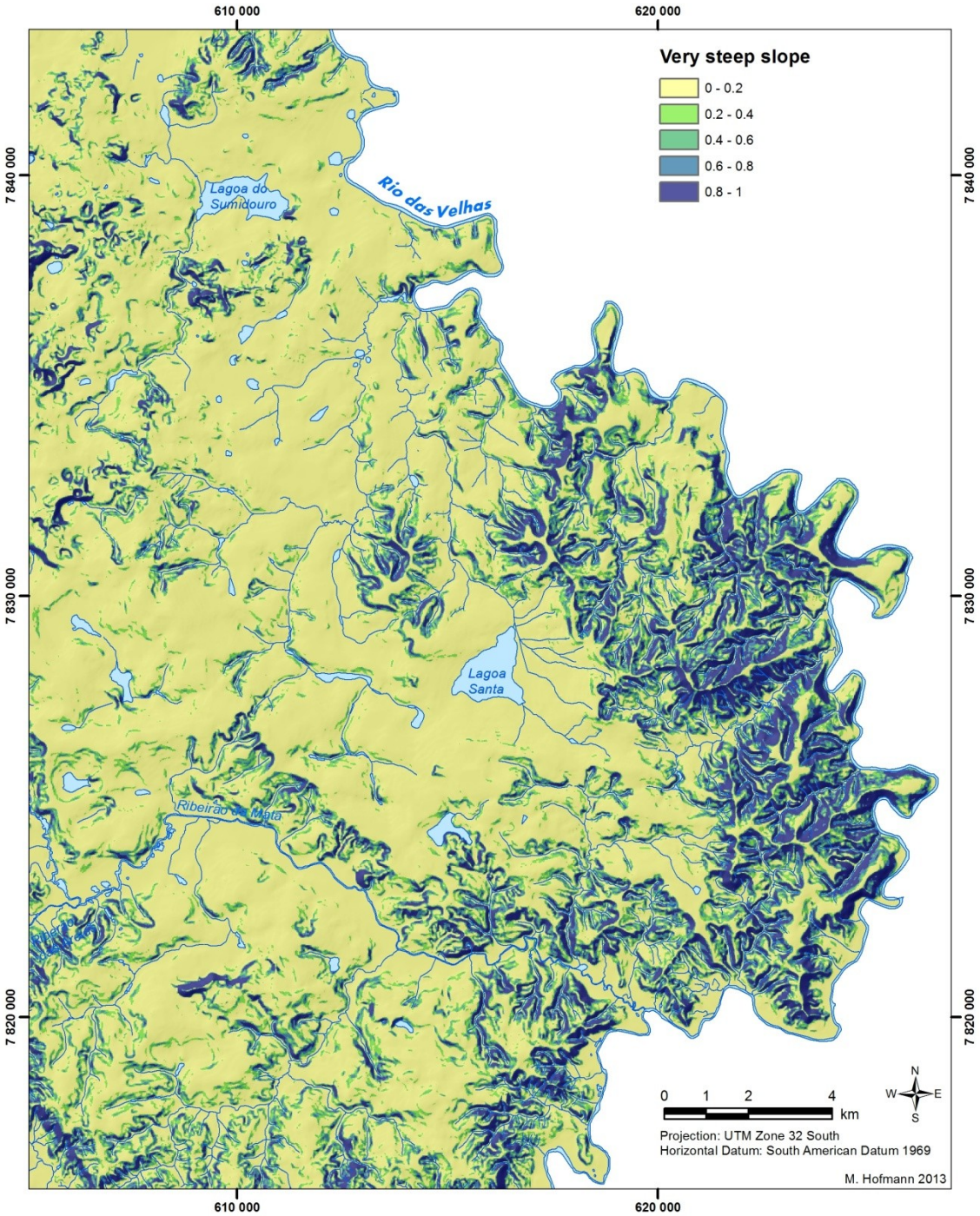
Map 10 Very flat slope

See also section 10.3.2



Map 11 Flat slope

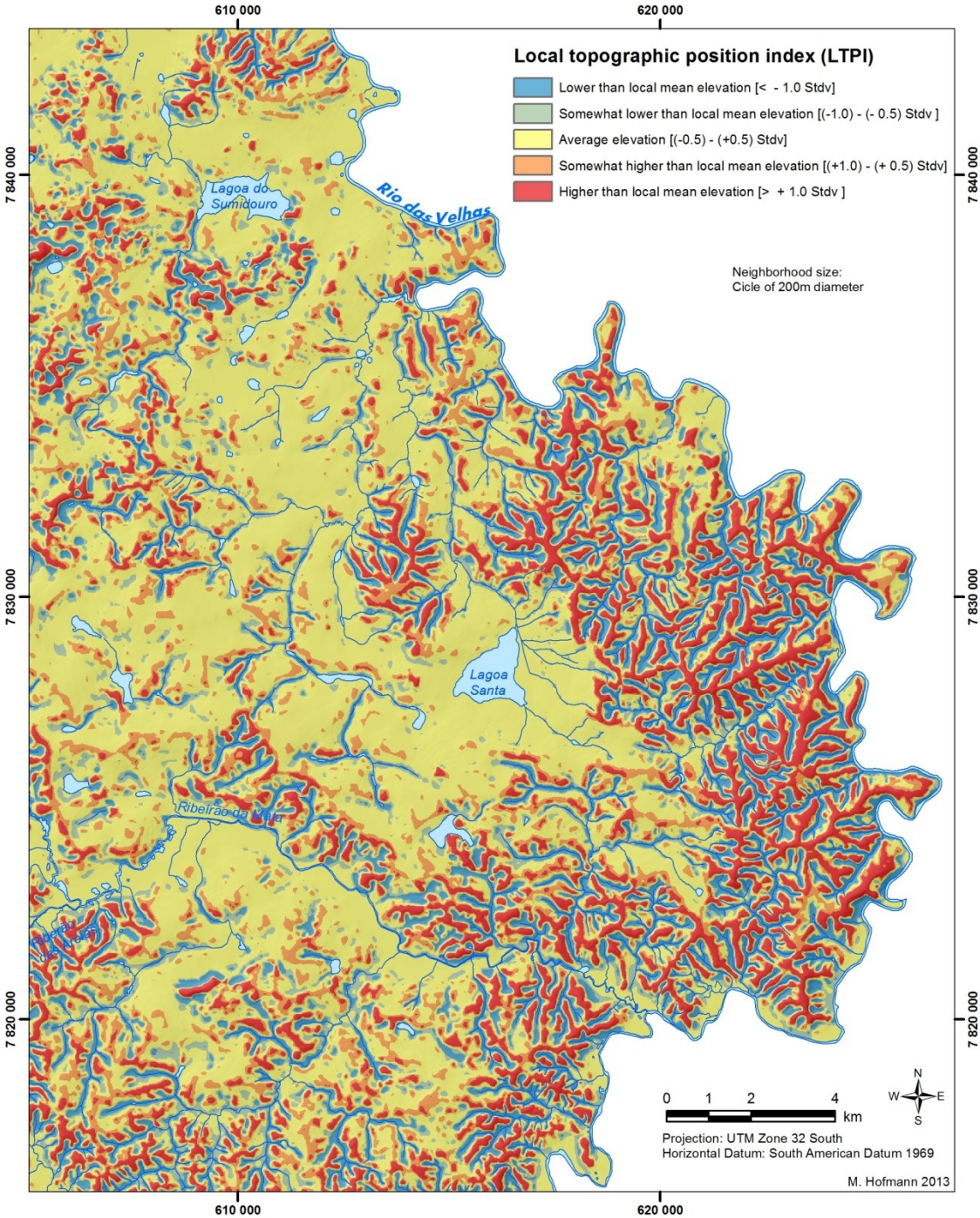
See also section 10.3.2



Map 12 Very steep slope

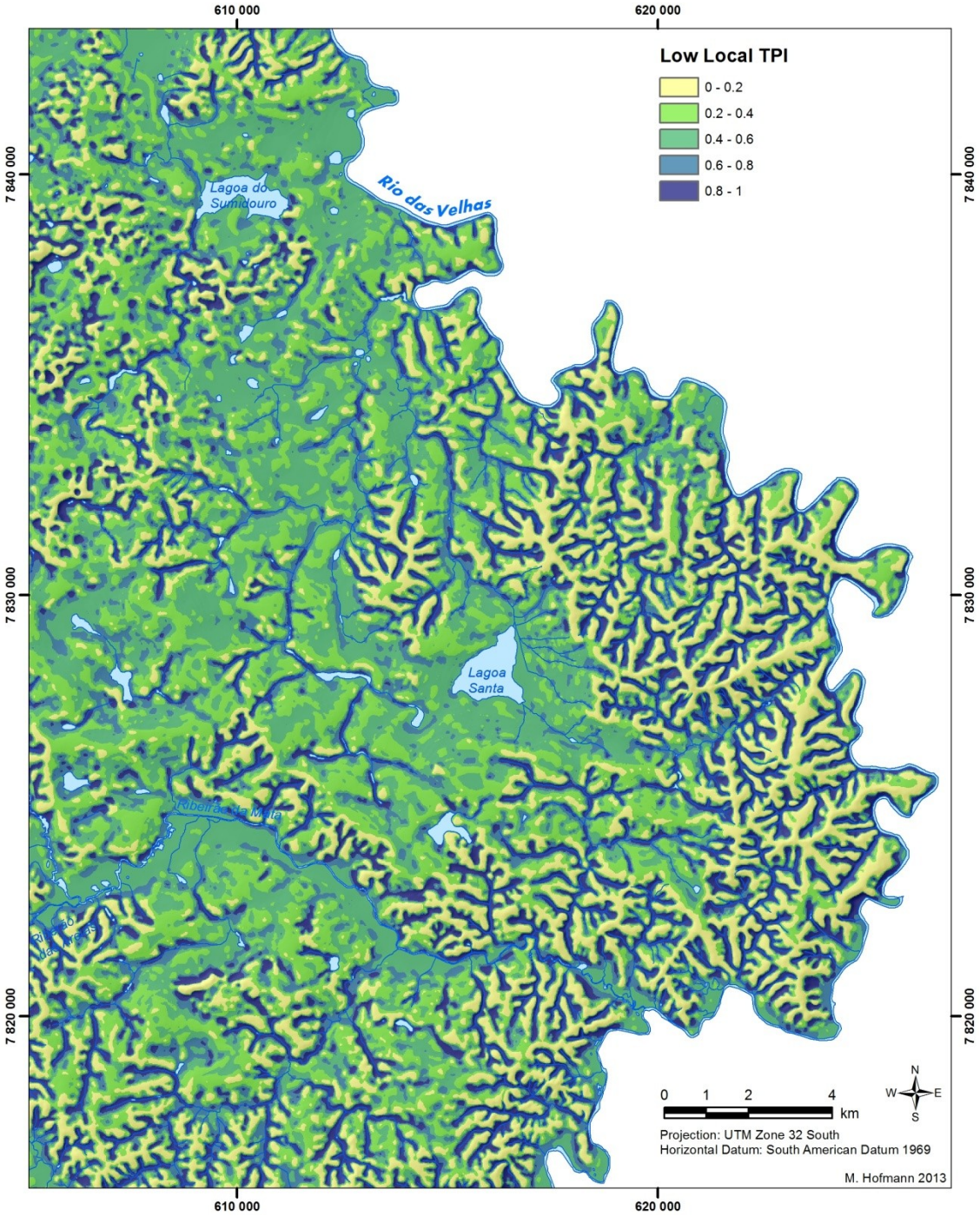
See also section 10.3.2

3. TPI



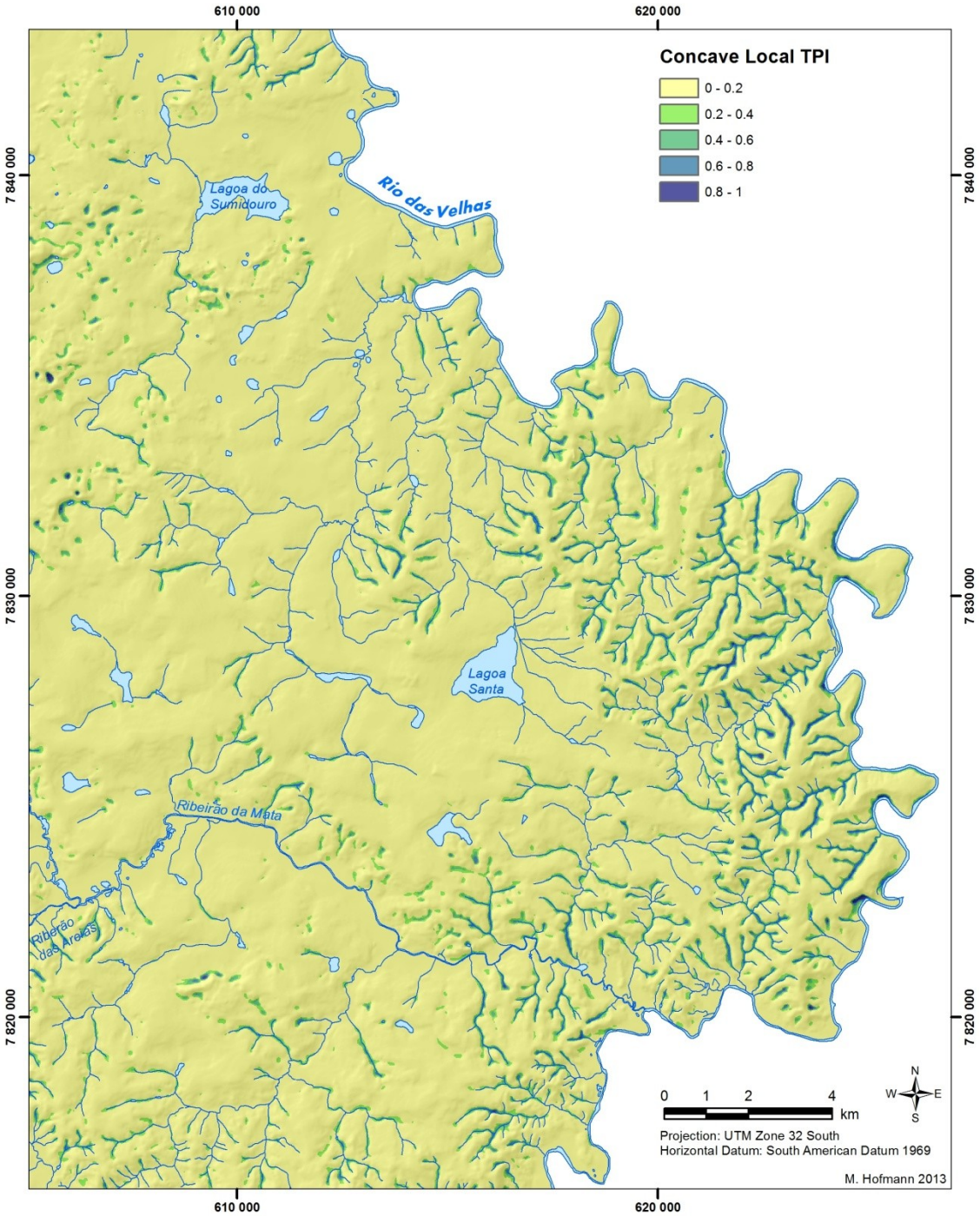
Map 13 Local topographic position index.

See also section 10.3.3.



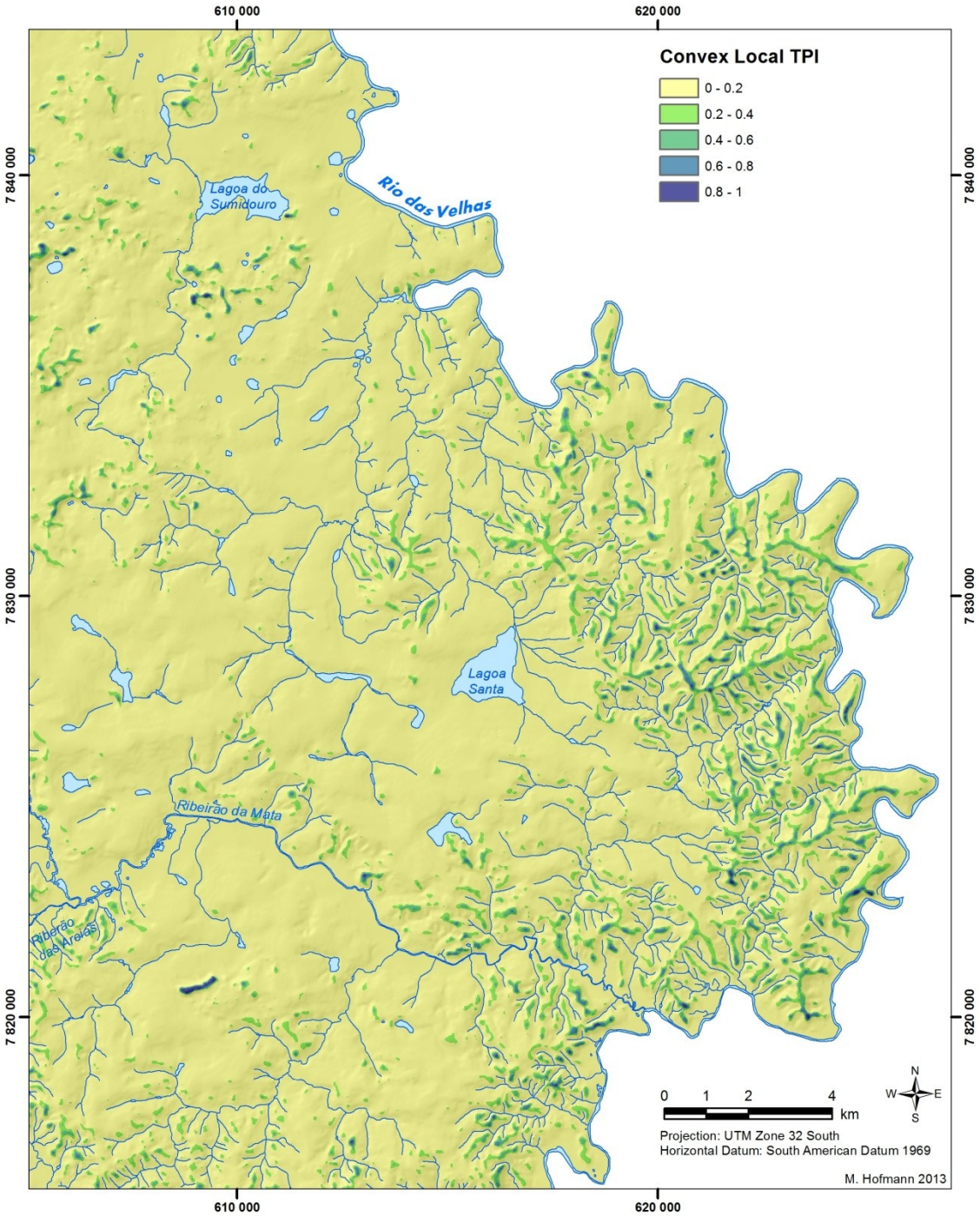
Map 14 Low Local topographic position index.

See also section 10.3.3.



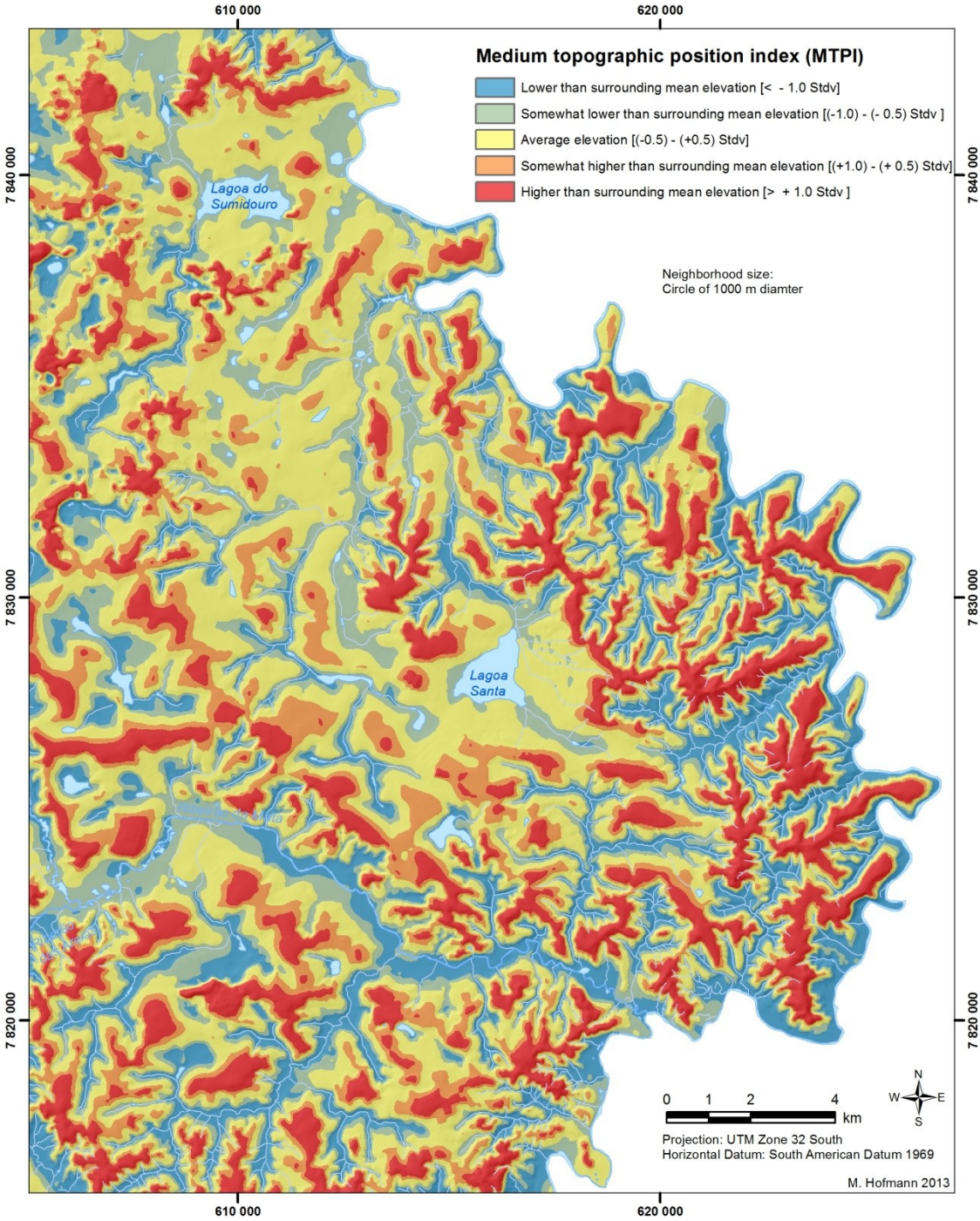
Map 15 Concave Local topographic position index.

See also section 10.3.3.



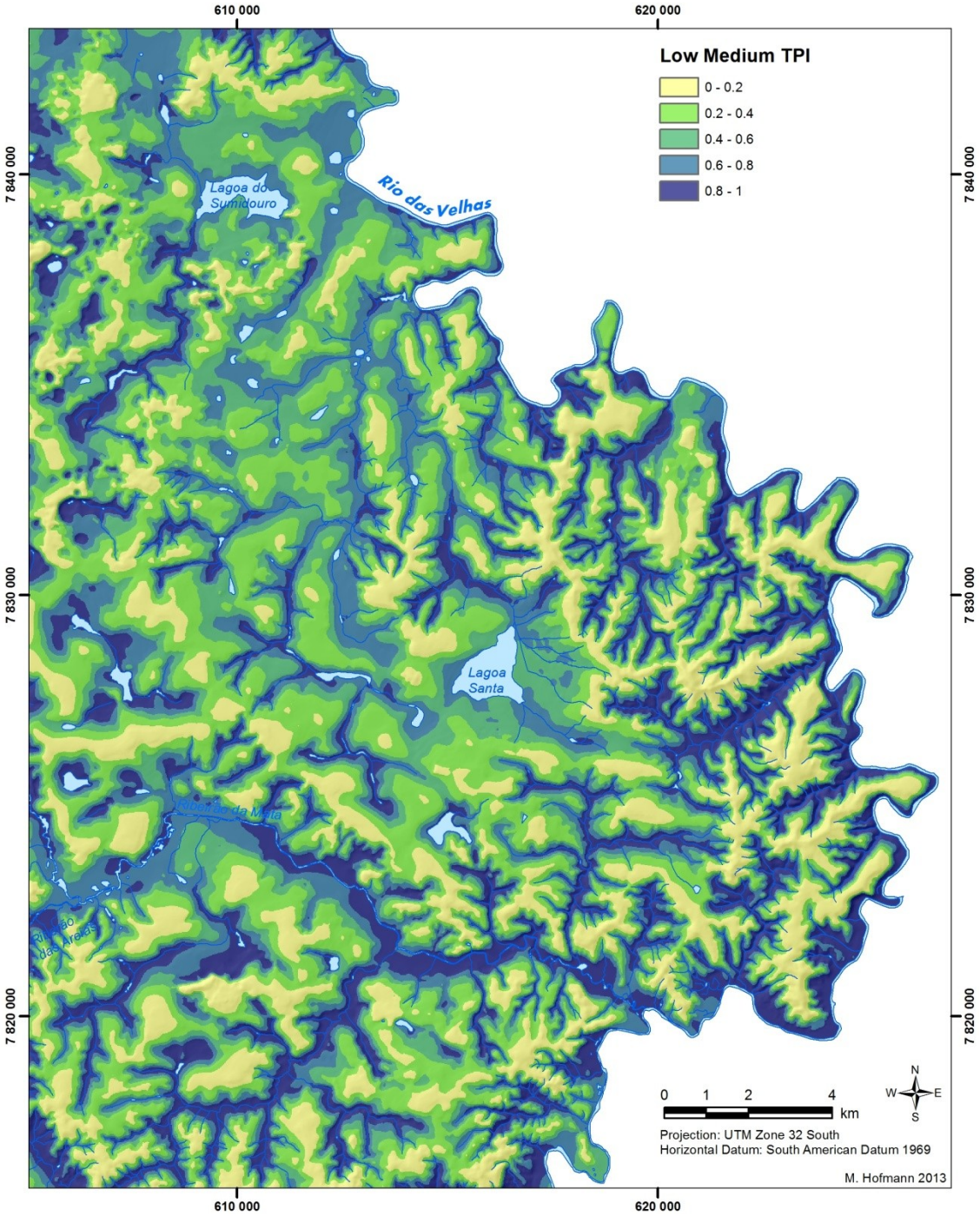
Map 16 Convex Local topographic position index.

See also section 10.3.3.



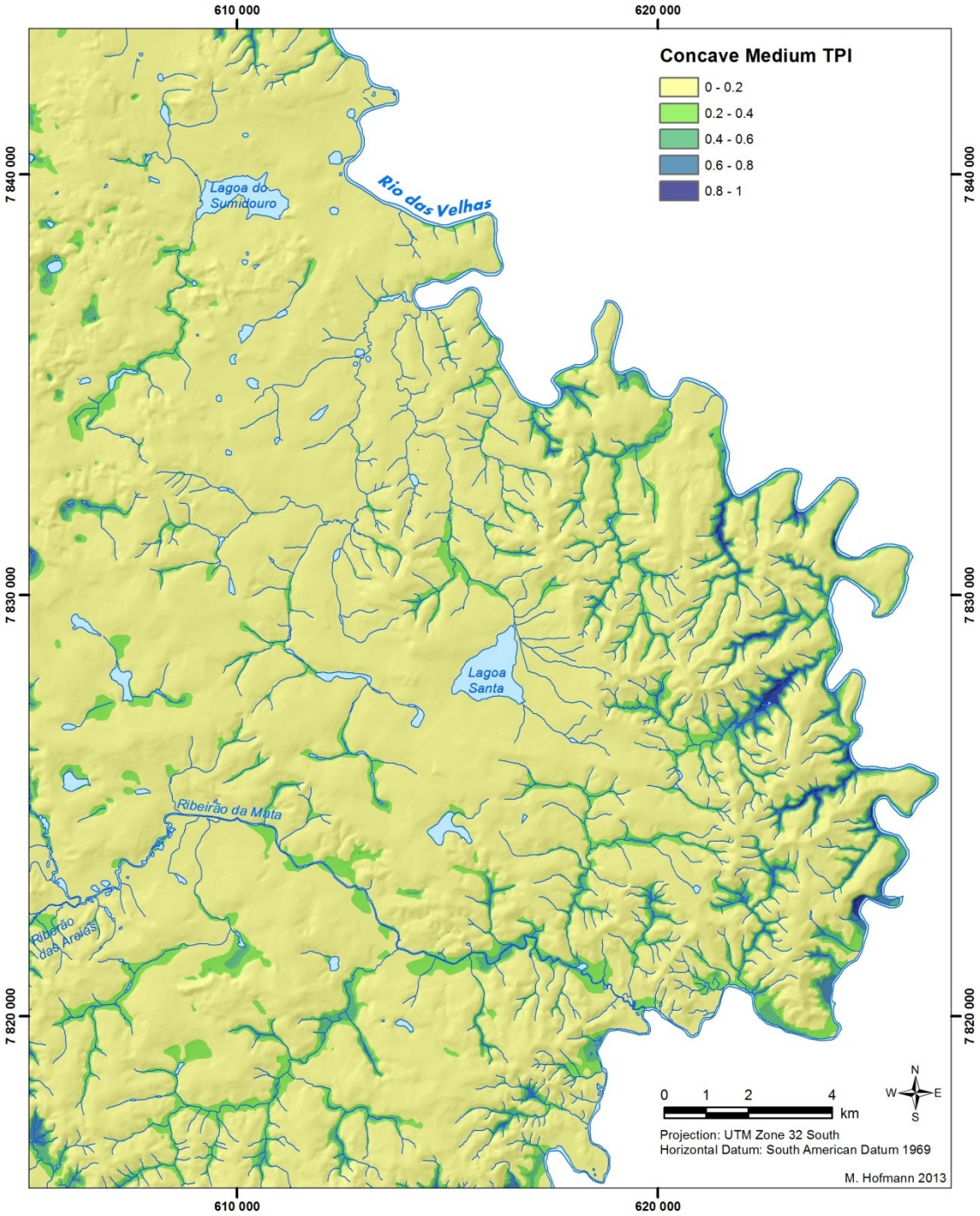
Map 17 Medium topographic position index.

See also section 10.3.3.



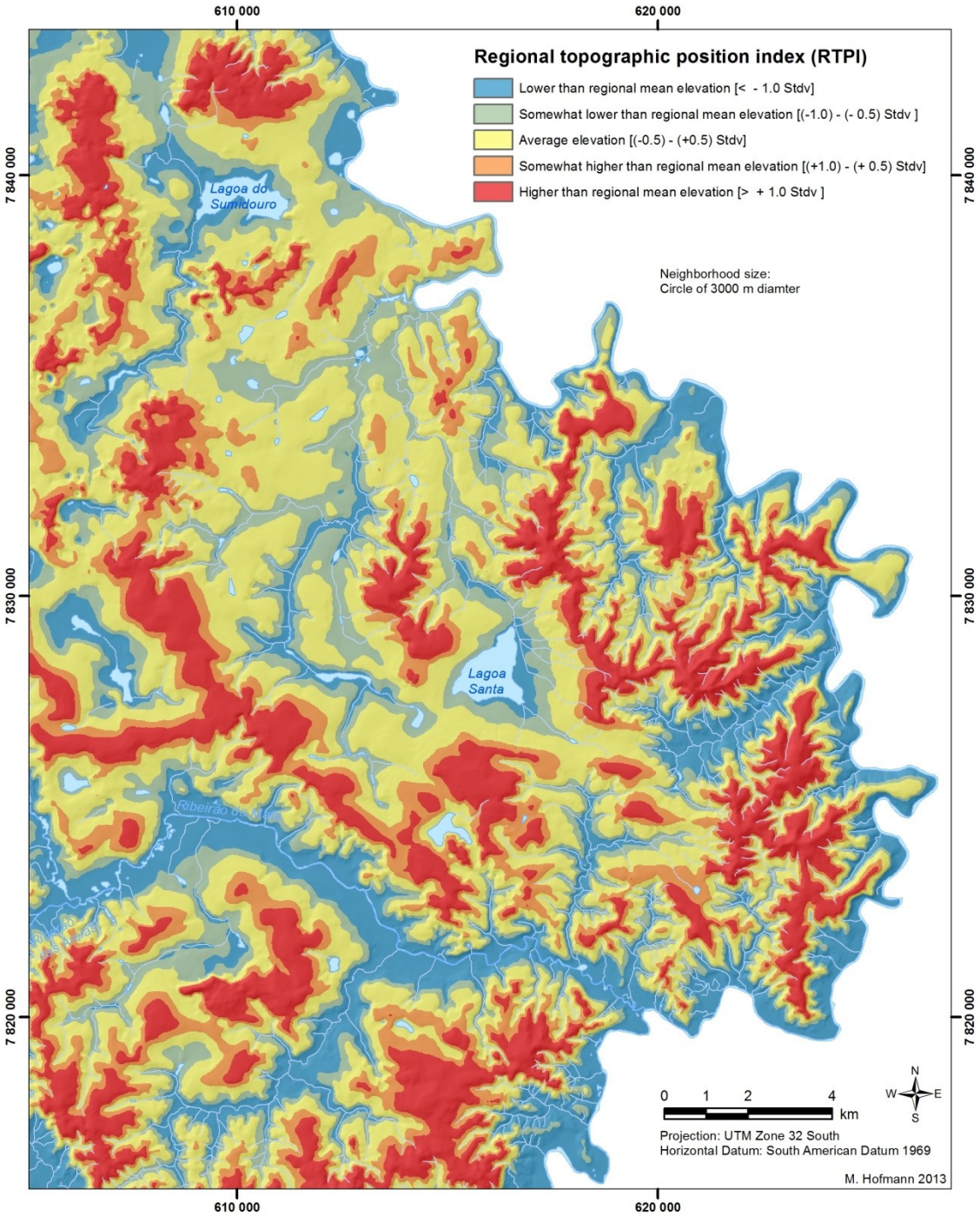
Map 18 Low medium topographic position index.

See also section 10.3.3.



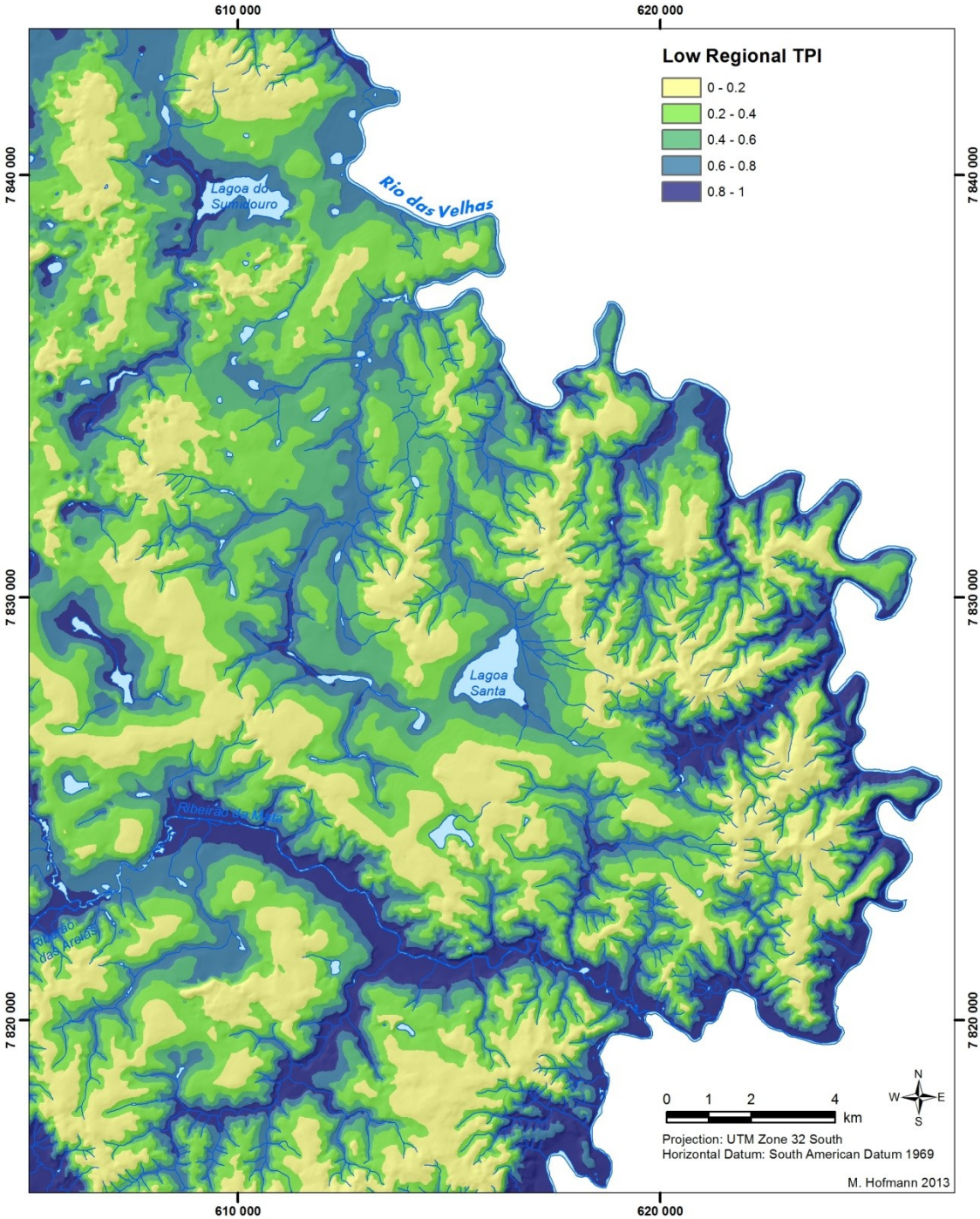
Map 19 Concave medium topographic position index.

See also section 10.3.3.



Map 20 Regional topographic position index.

See also section 10.3.3.

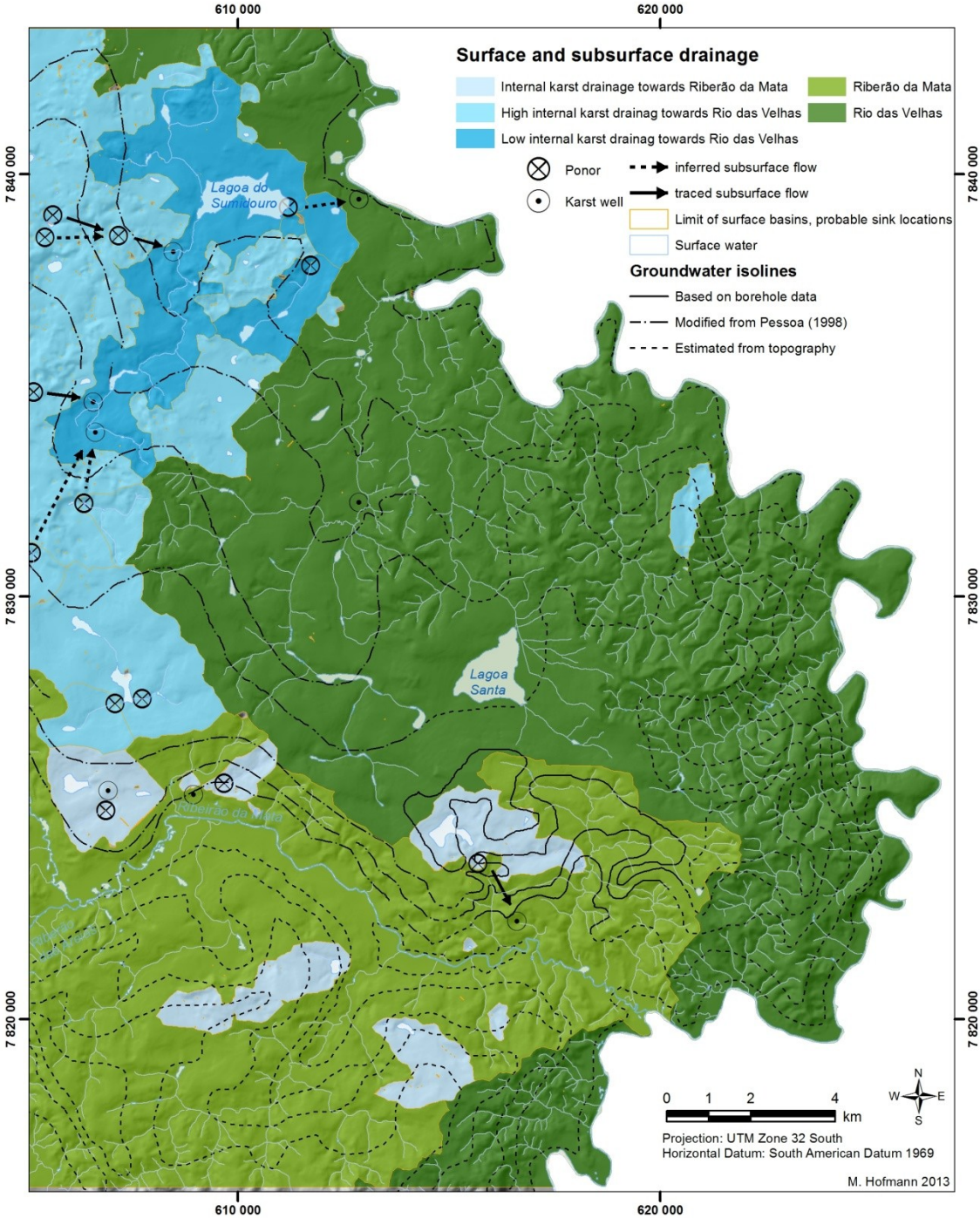


Map 21 Low Regional topographic position index.

See also section 10.3.3.

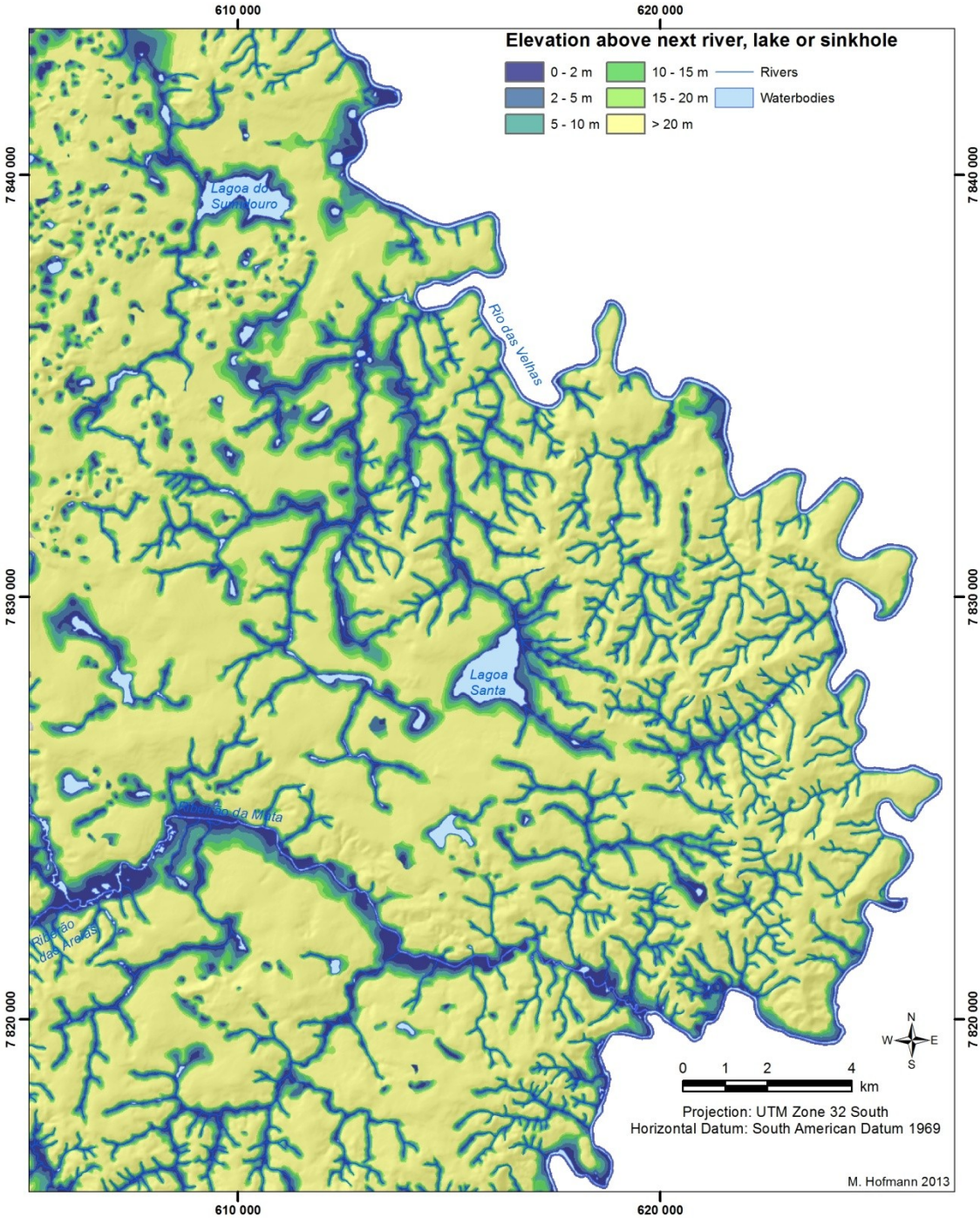
C. Surface hydrology

1. Surface and subsurface drainage



Map 22 Surface and subsurface drainage in the study area.

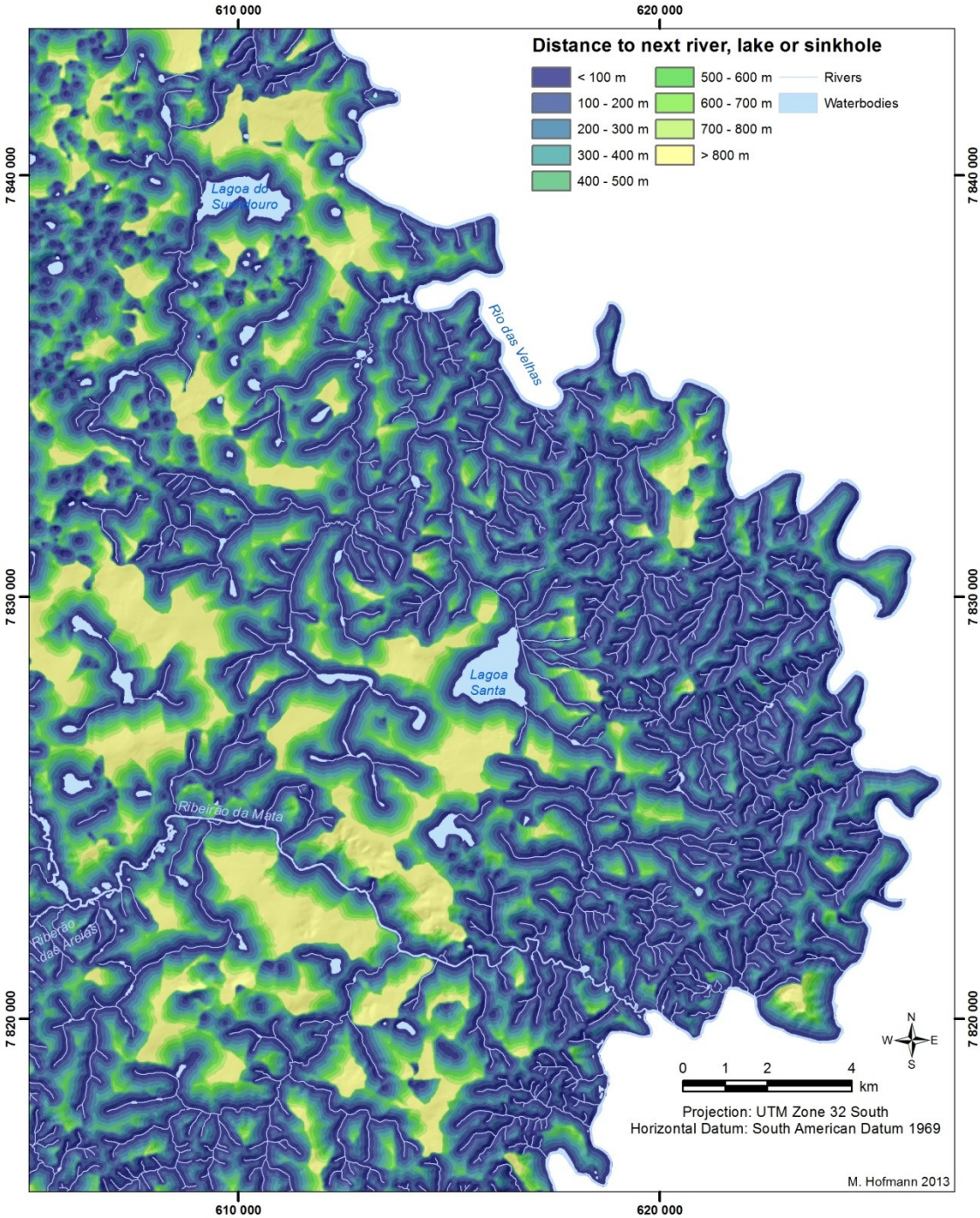
2. Elevation above surface water or sinks



Map 23 Elevation above river, lake or sinkhole.

The method is described in section 10.4

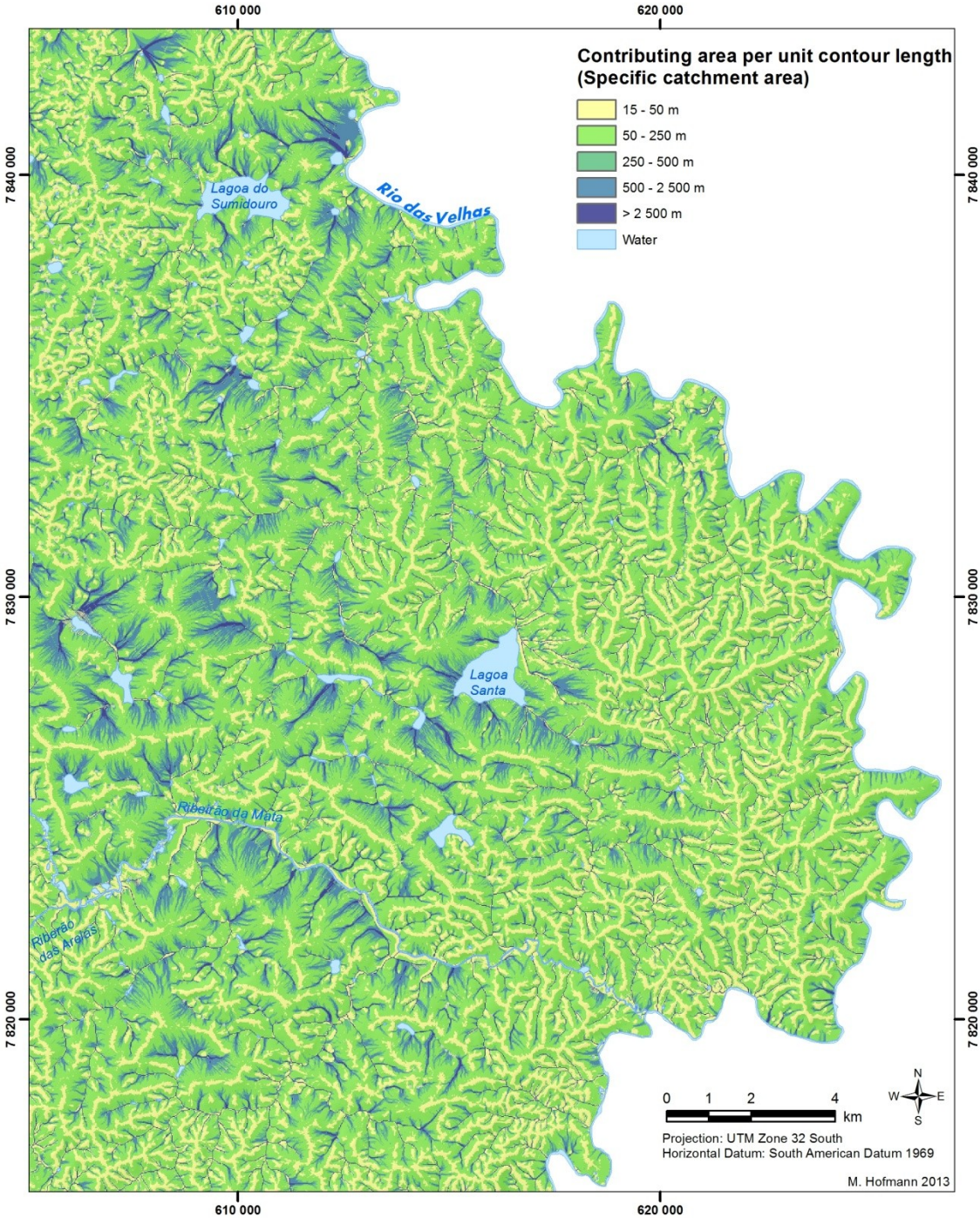
3. Distance to surface water or sinks



Map 24 Distance to river, lake or sinkhole.

The method is described in section 10.4

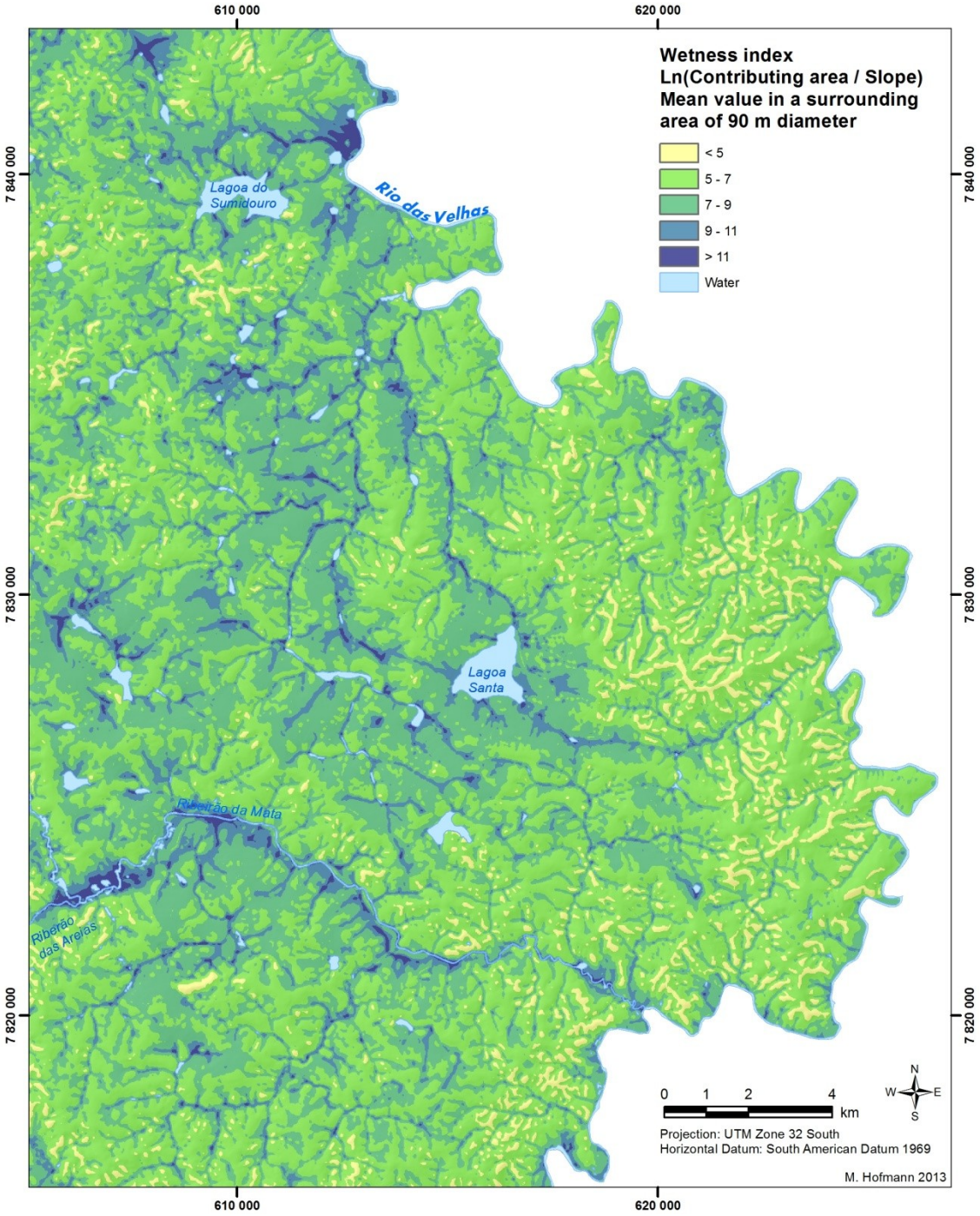
4. Specific catchment area



Map 25 Contributing area per unit contour length.

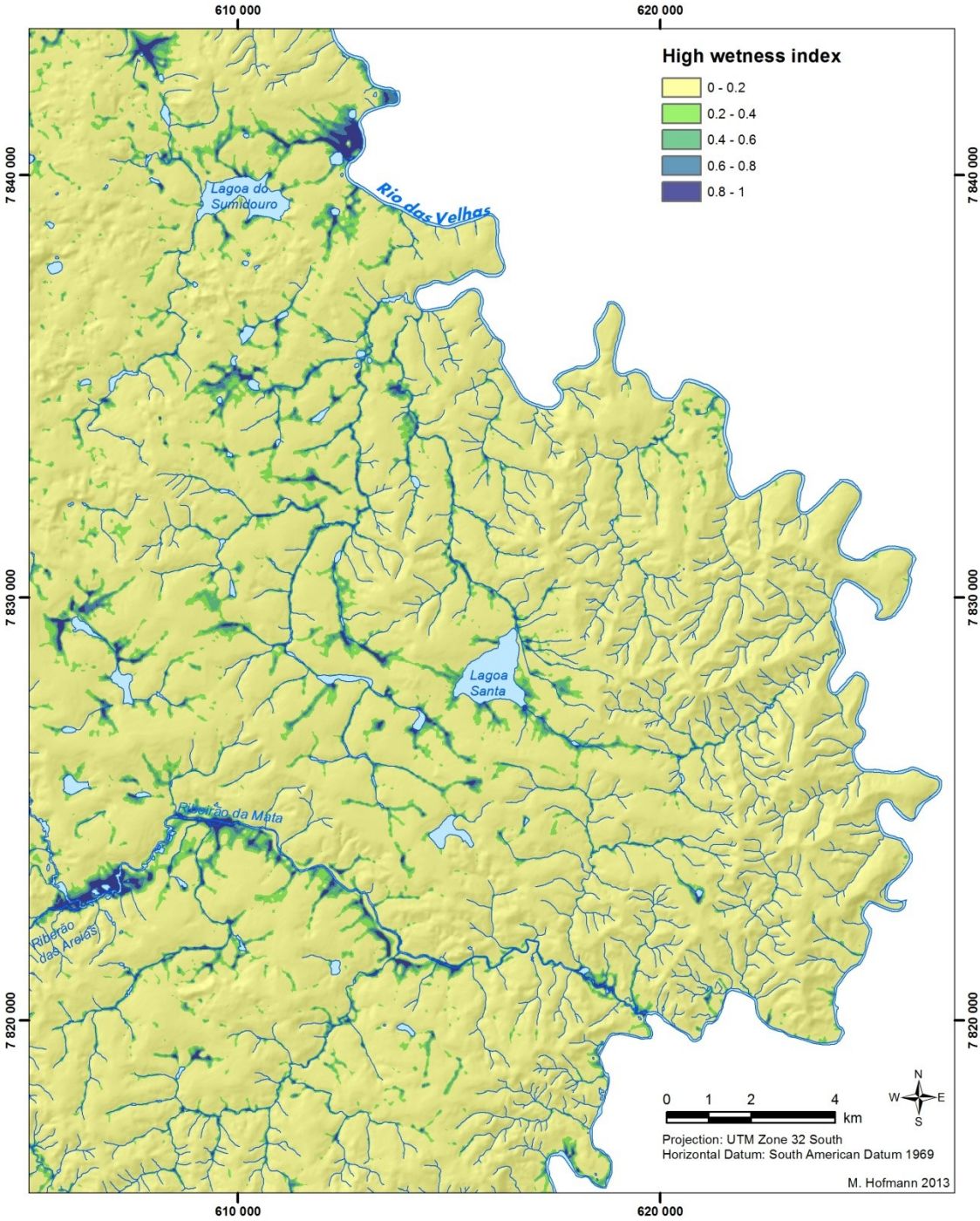
The method is described in section 10.4

5. Wetness index



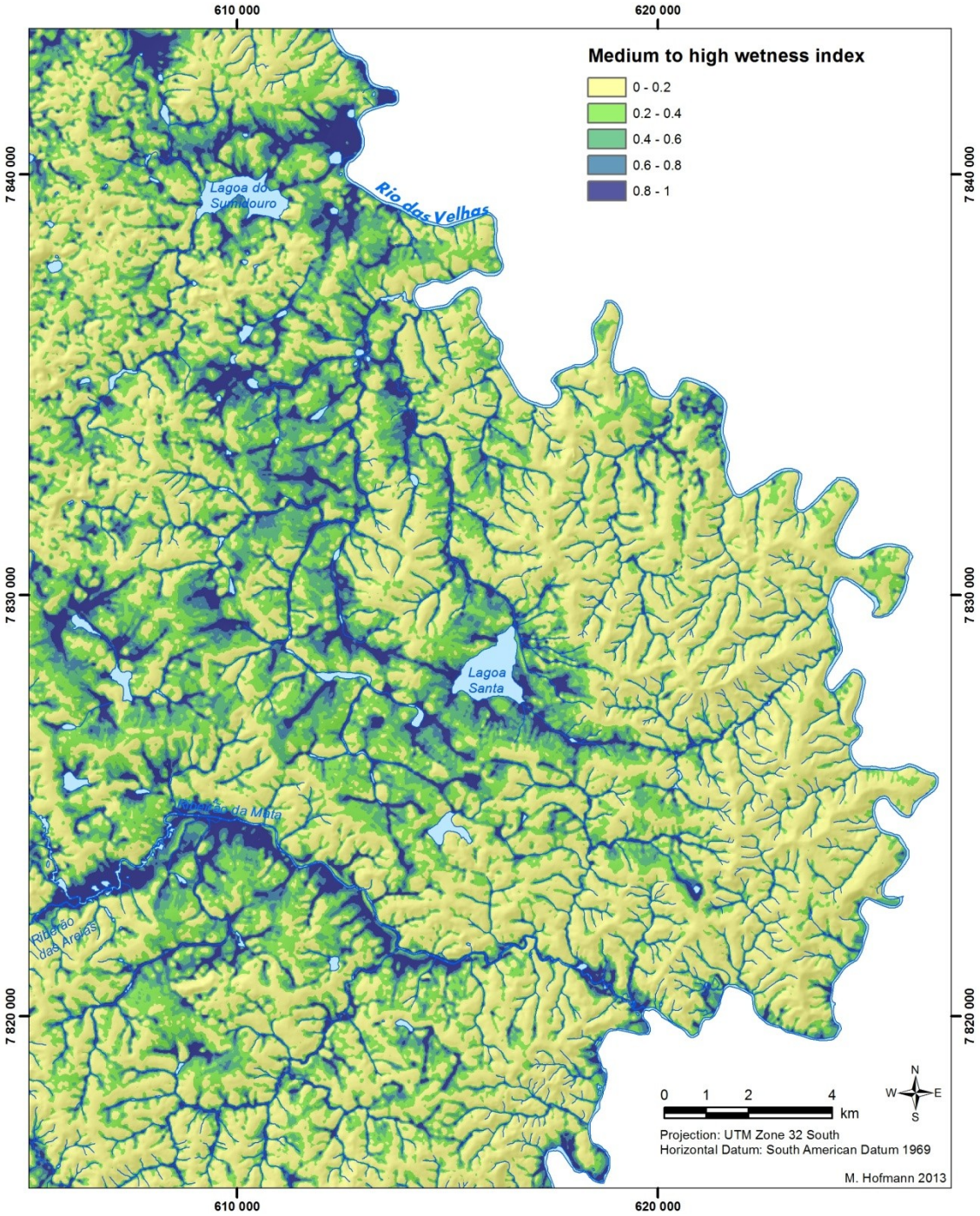
Map 26 Wetness index.

The method is described in section 10.4



Map 27 High wetness index.

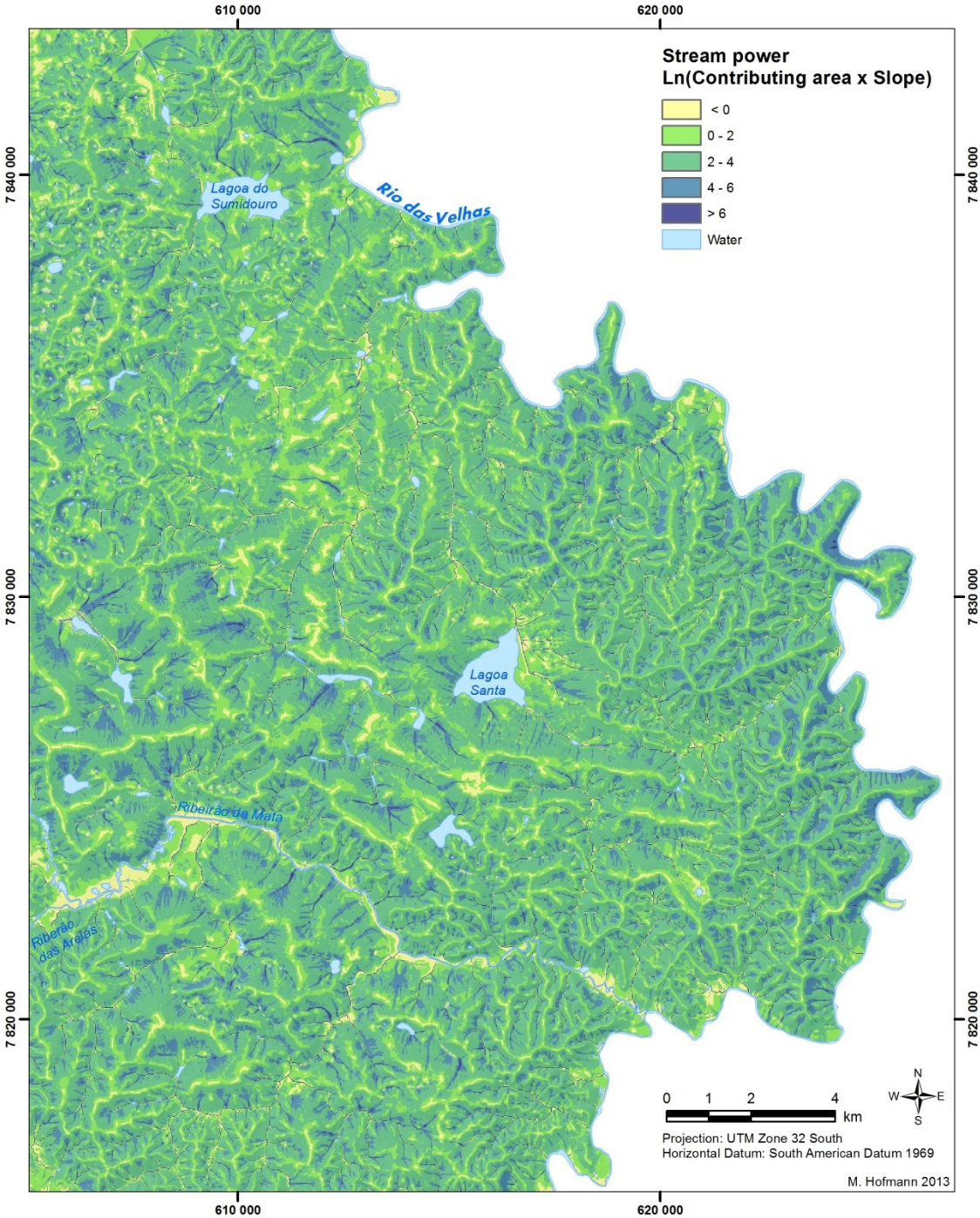
The method is described in section 10.4



Map 28 Medium to high wetness index.

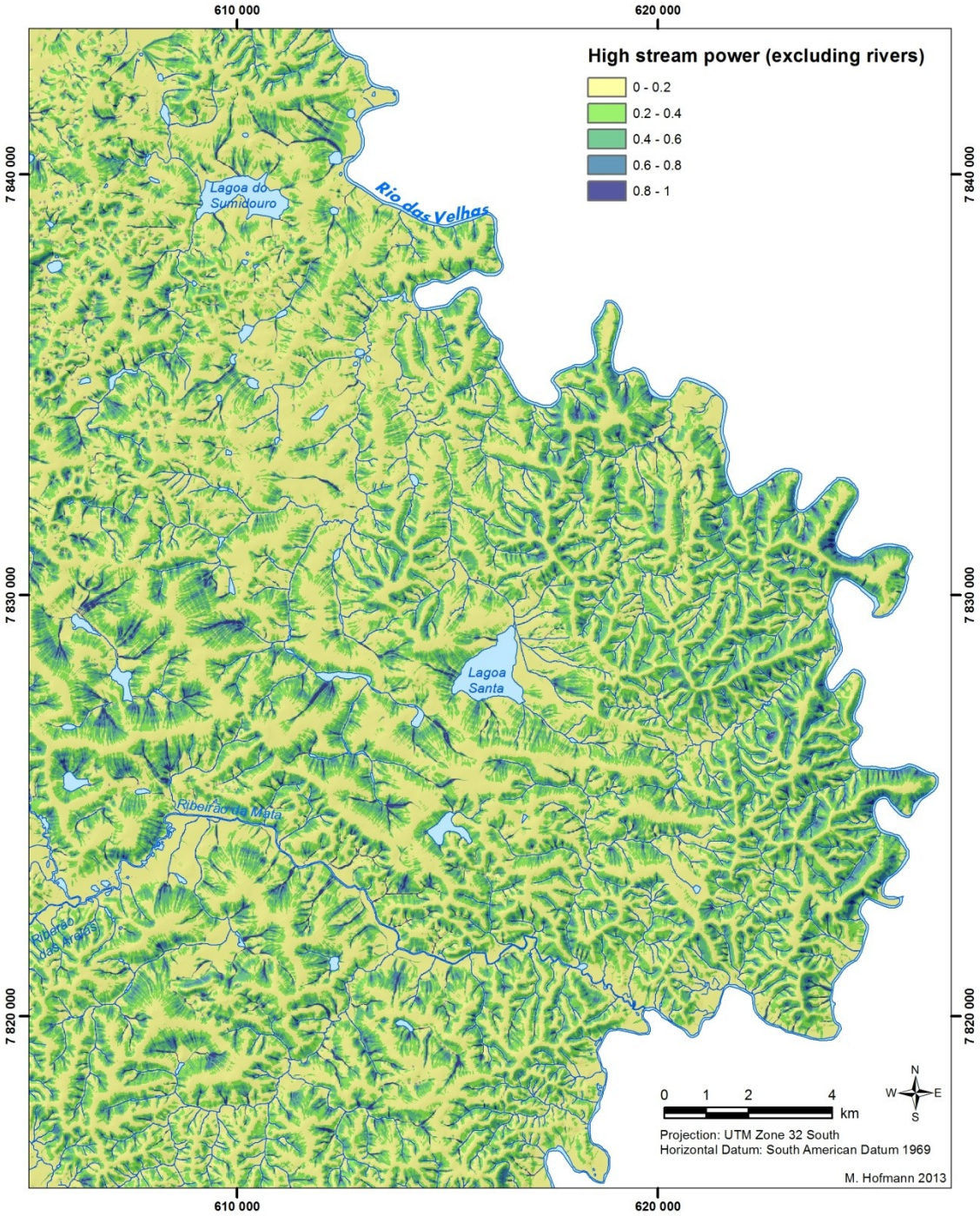
The method is described in section 10.4

6. Stream power



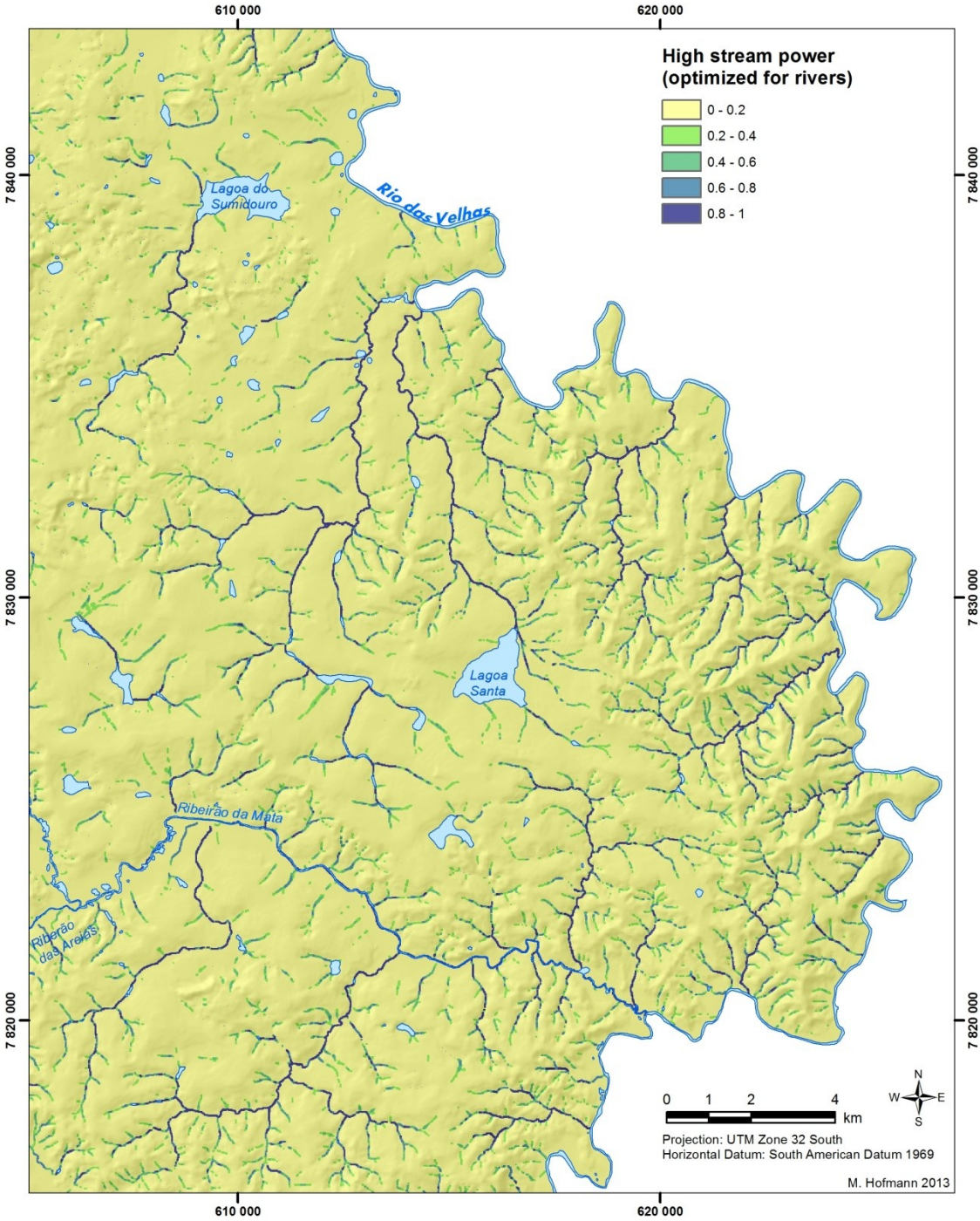
Map 29 Stream power.

The method is described in section 10.4



Map 30 High stream power (excluding rivers).

The method is described in section 10.4

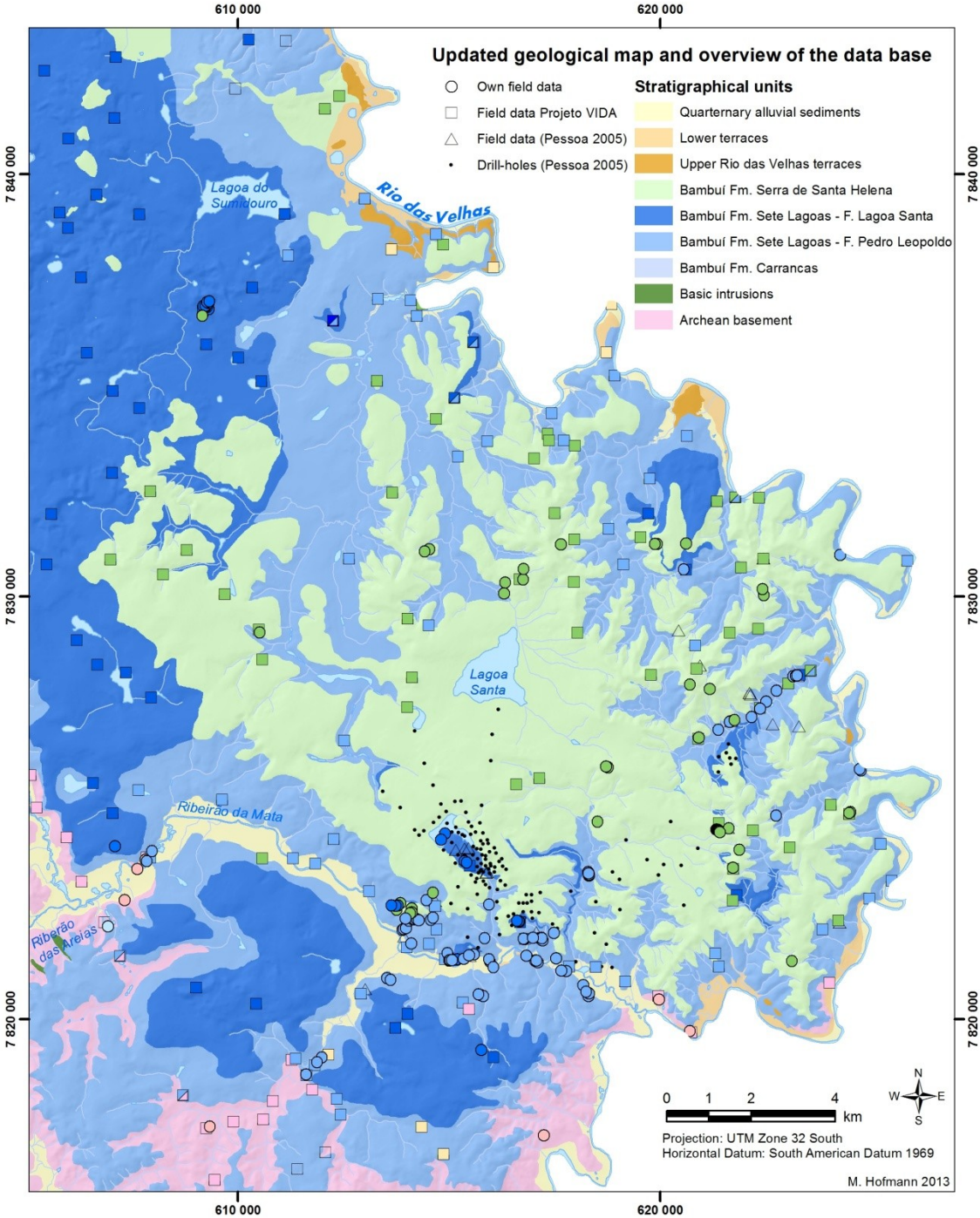


Map 31 High stream power (optimized for rivers).

The method is described in section 10.4

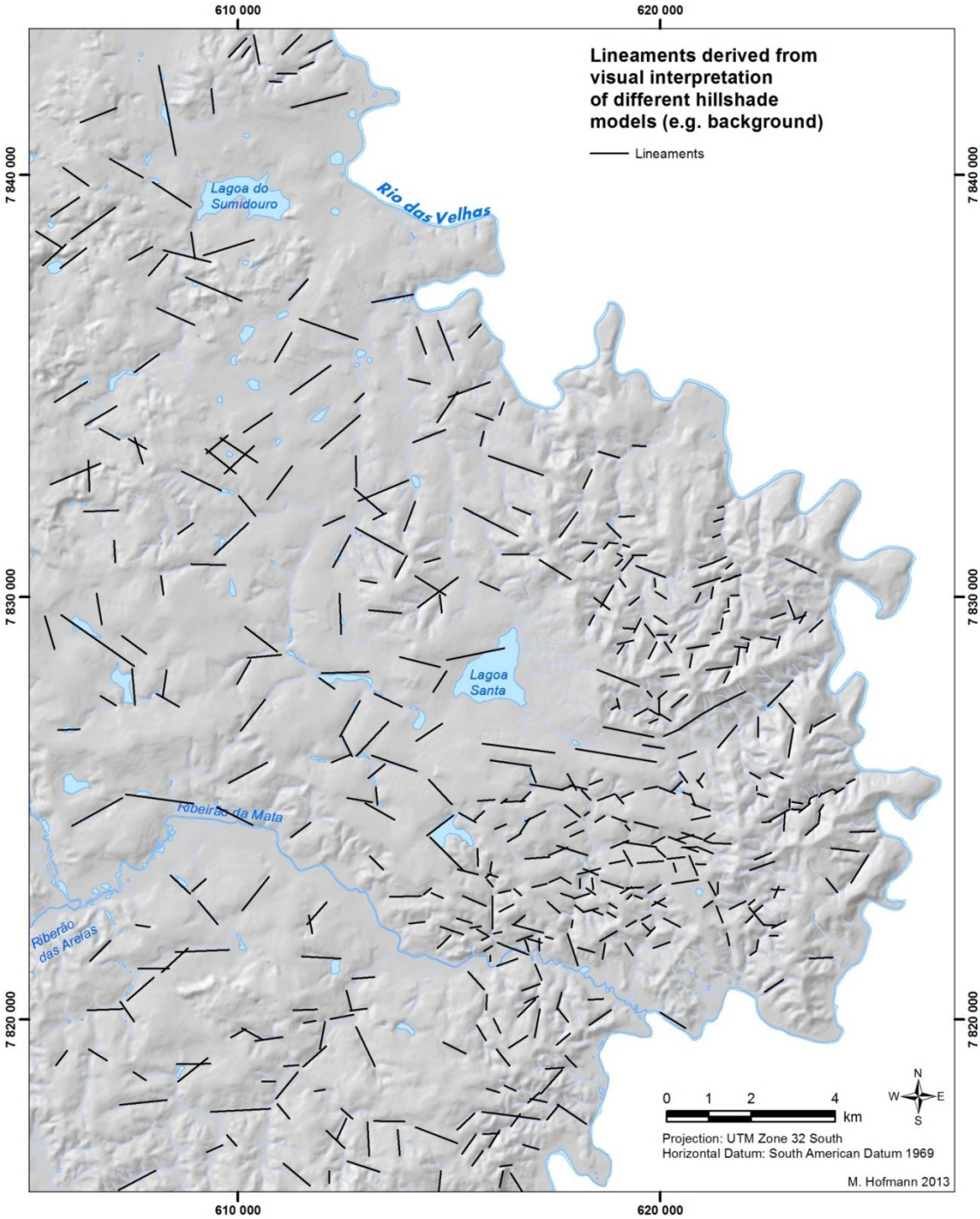
D. Geology

1. Geological database



Map 32 Updated geological map and overview of the data base

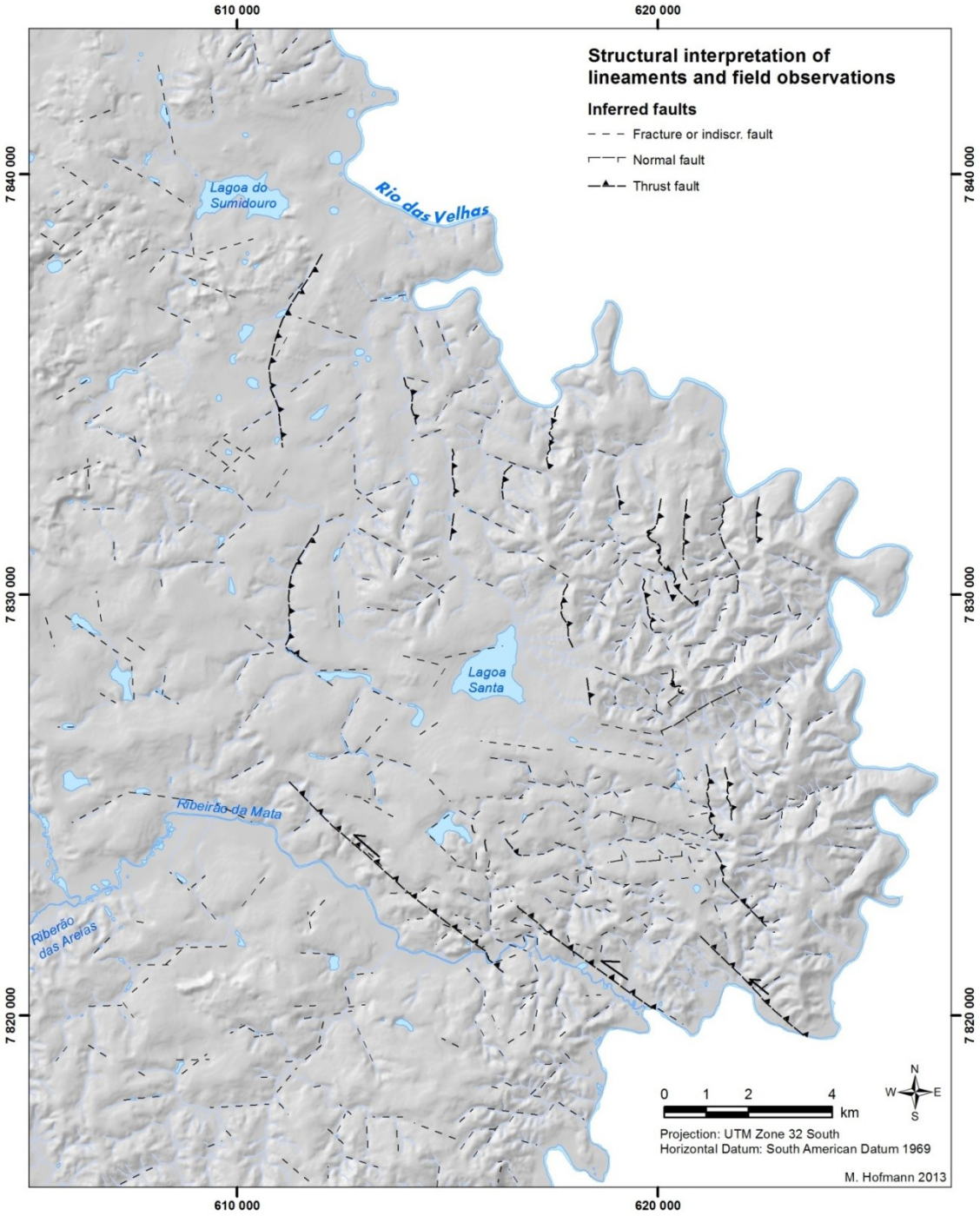
2. Lineaments



Map 33 Map of lineaments

The maps was derived from manual interpretation of the hillshade display (background) of the digital elevation model.

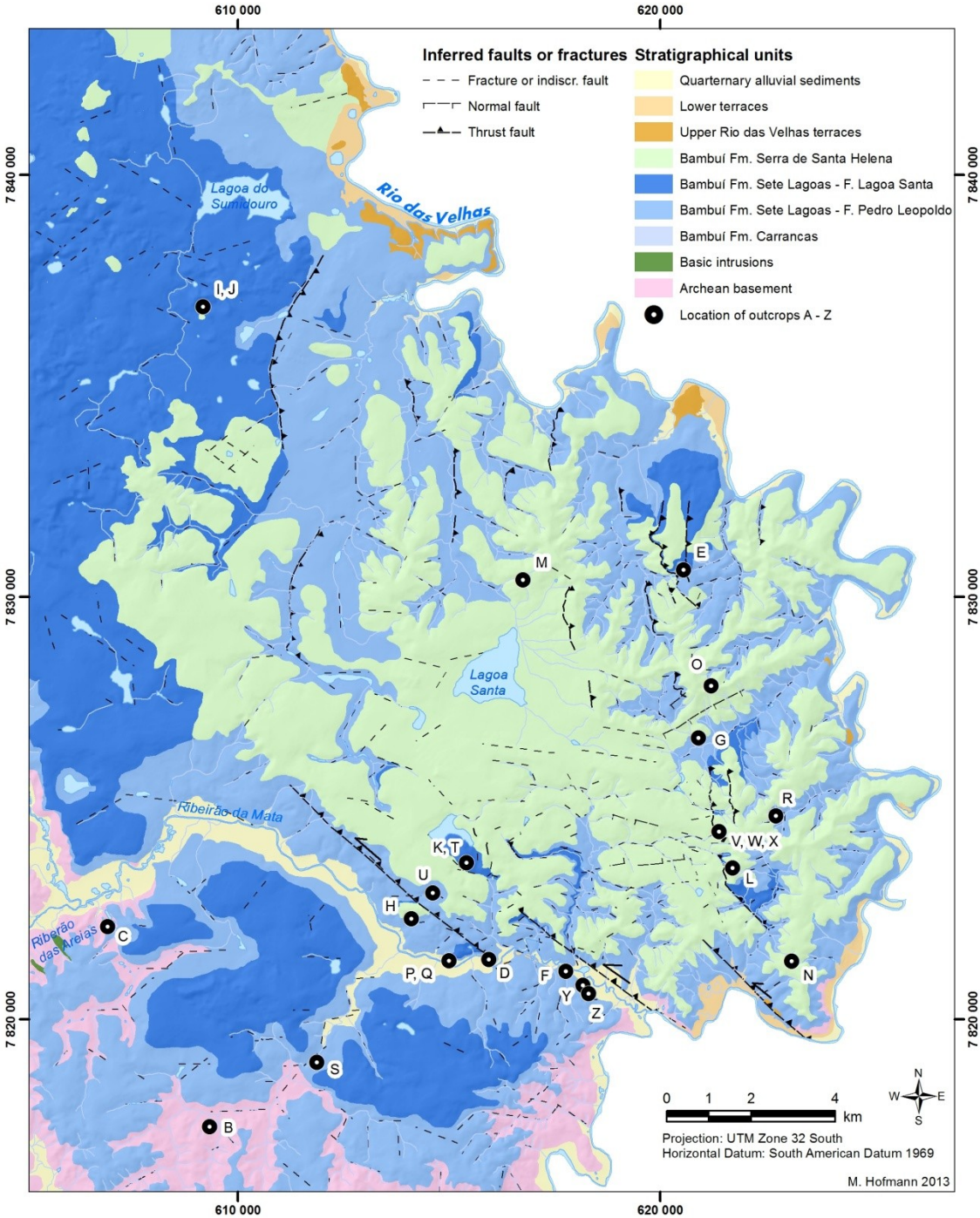
3. Structure



Map 34 Geological structures

Interpretation of lineaments and field observation for the structural setting of the study area.

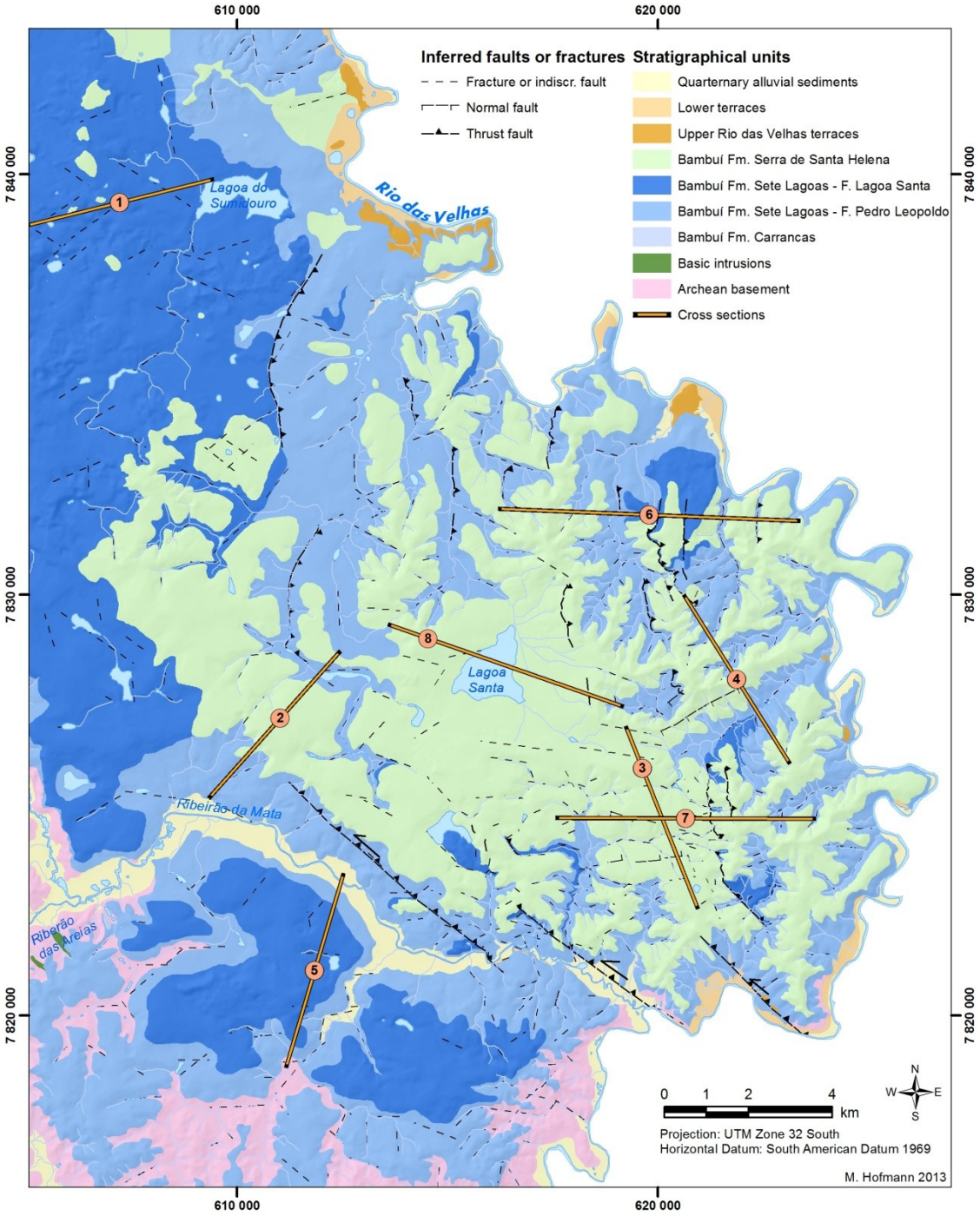
4. Location of outcrop photos



Map 35 Updated geological map and locations of the outcrops B - Z.

Outcrop A is just south of the study area near the bifurcation of MG-10 and MG-424.

5. Geological cross-sections



Map 36 Updated geological map with cross-sections.

The cross sections are shown on page 374 and 375.

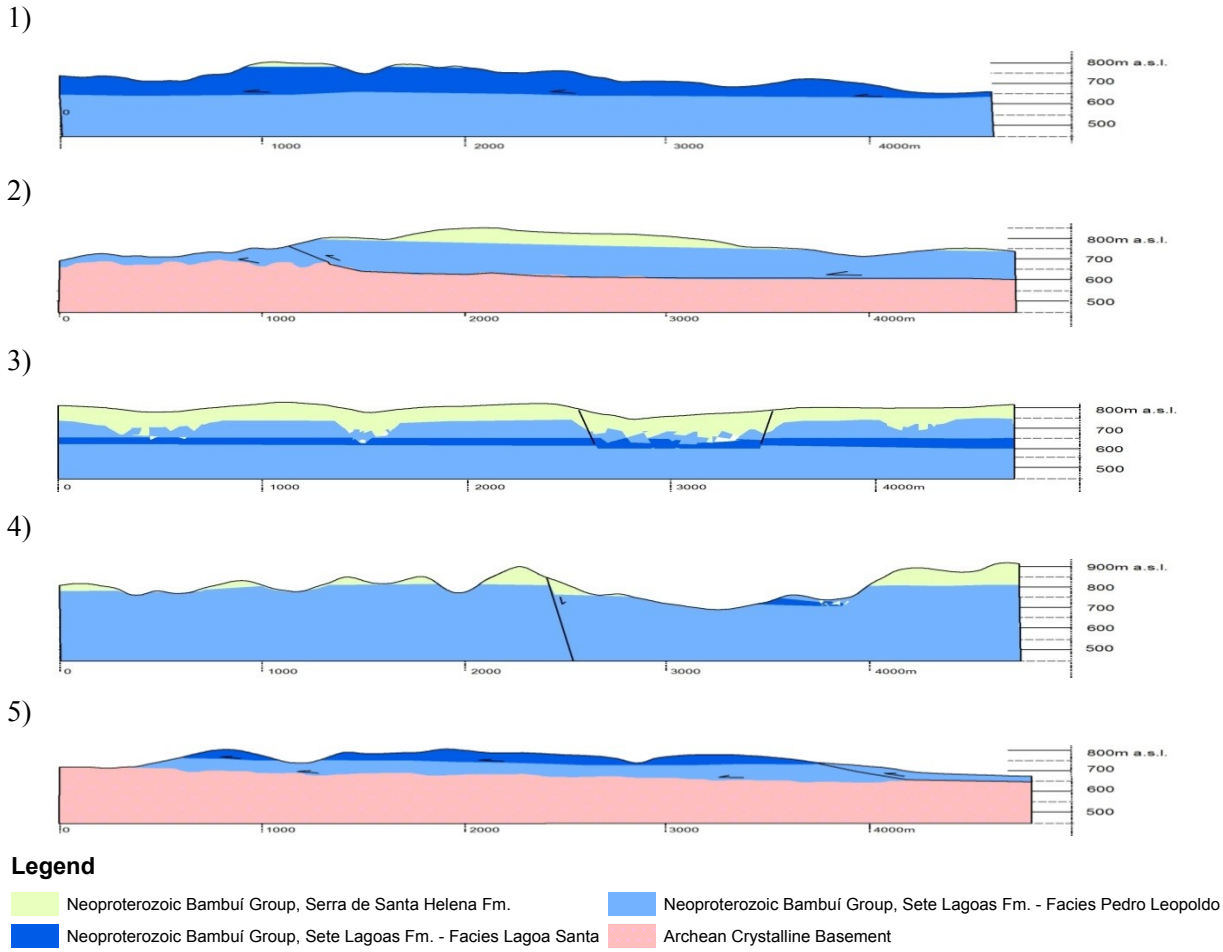
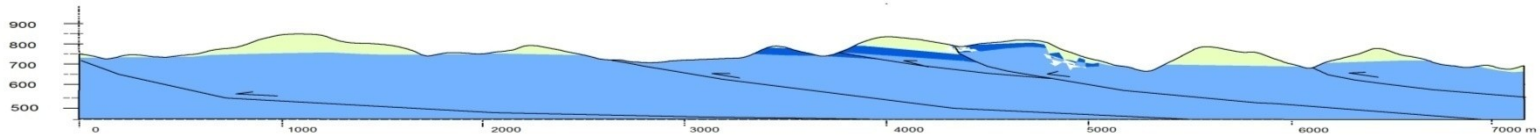


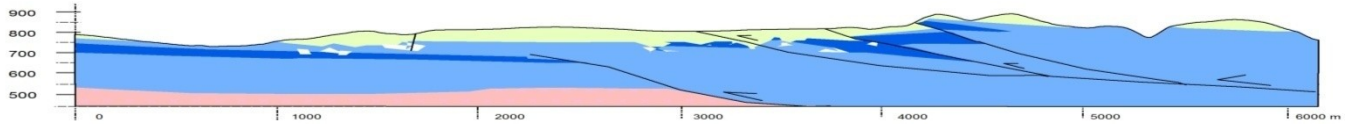
Figure Annex II - 1

Geological cross-sections 1 – 5. Their location is indicated in Map 36.

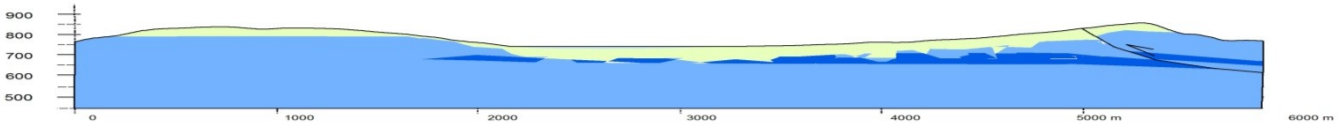
6)



7)



8)

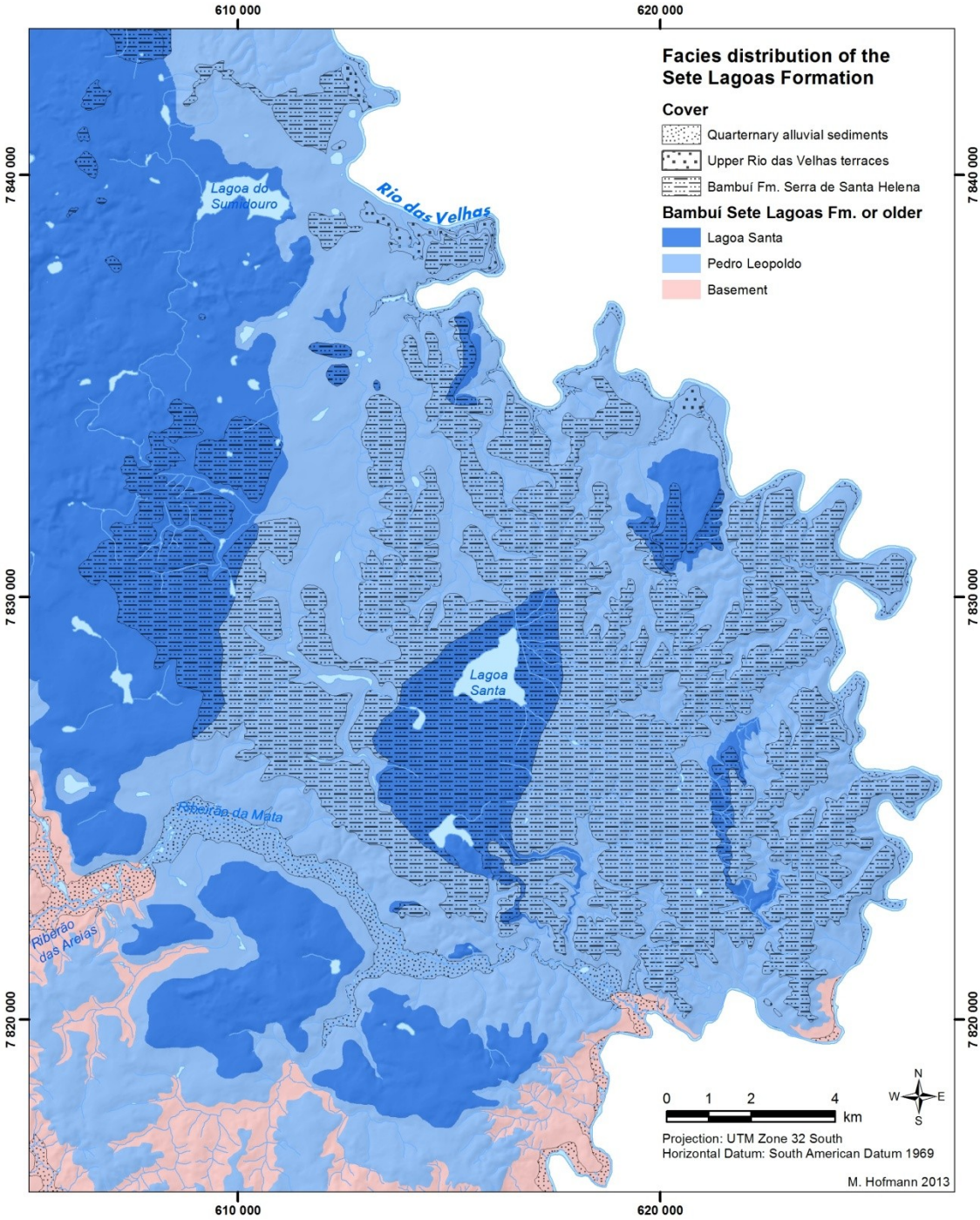


Legend

- Neoproterozoic Bambuí Group, Serra de Santa Helena Fm.
- Neoproterozoic Bambuí Group, Sete Lagoas Fm. - Facies Pedro Leopoldo
- Neoproterozoic Bambuí Group, Sete Lagoas Fm. - Facies Lagoa Santa
- Archean Crystalline Basement

Figure Annex II - 2 Geological cross-sections 6 - 8. Their location is indicated in Map 36.

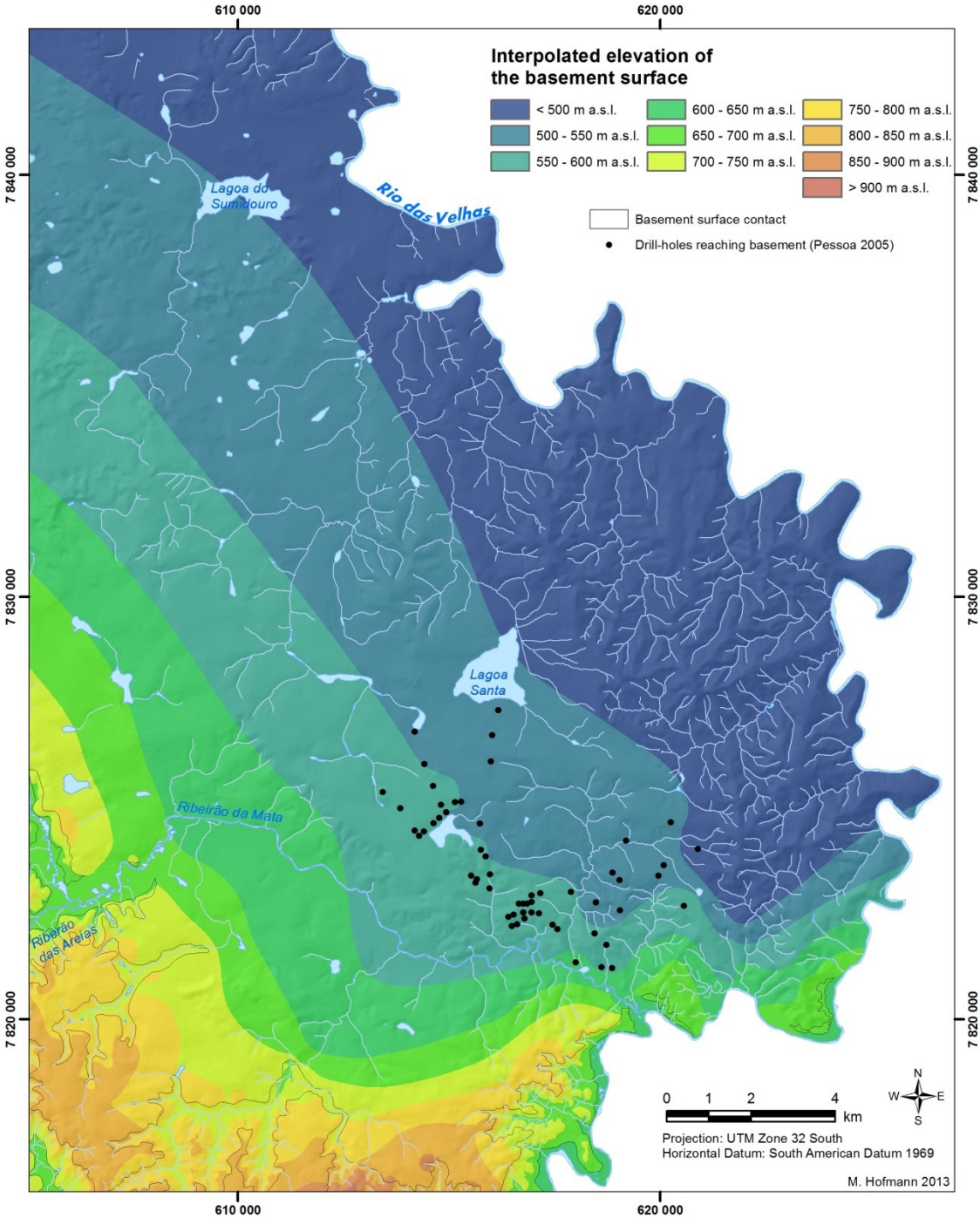
6. Facies distribution of the Sete Lagoas Fm.



Map 37 Facies distribution of the Sete Lagoas Formation.

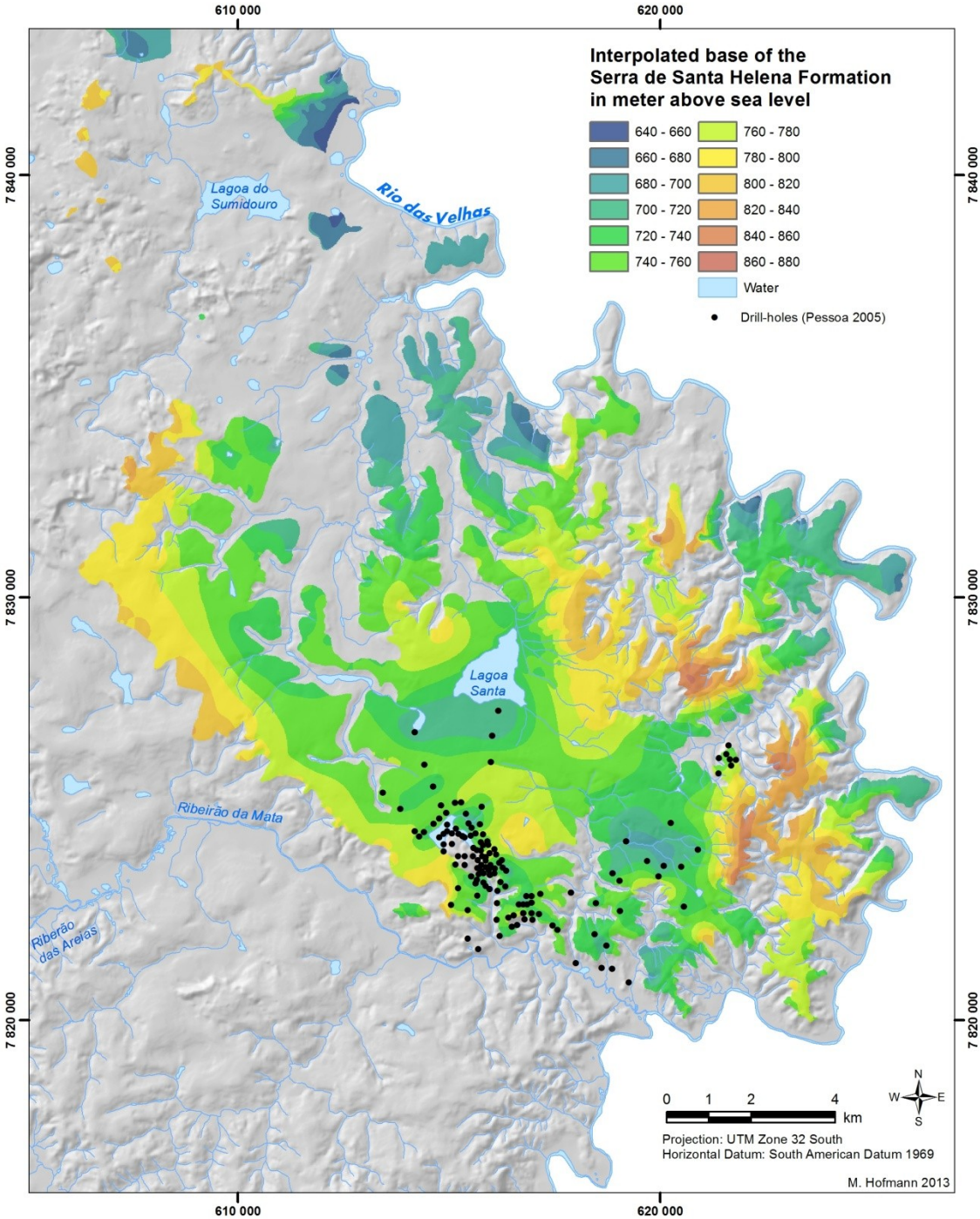
The map indicates the character of the top layer of the Sete Lagoas Formation. Especially in the eastern part of the study area, stacked layers of pure and impure carbonates are common (see also the cross-sections on page 374 and 375).

7. Interpolated surfaces



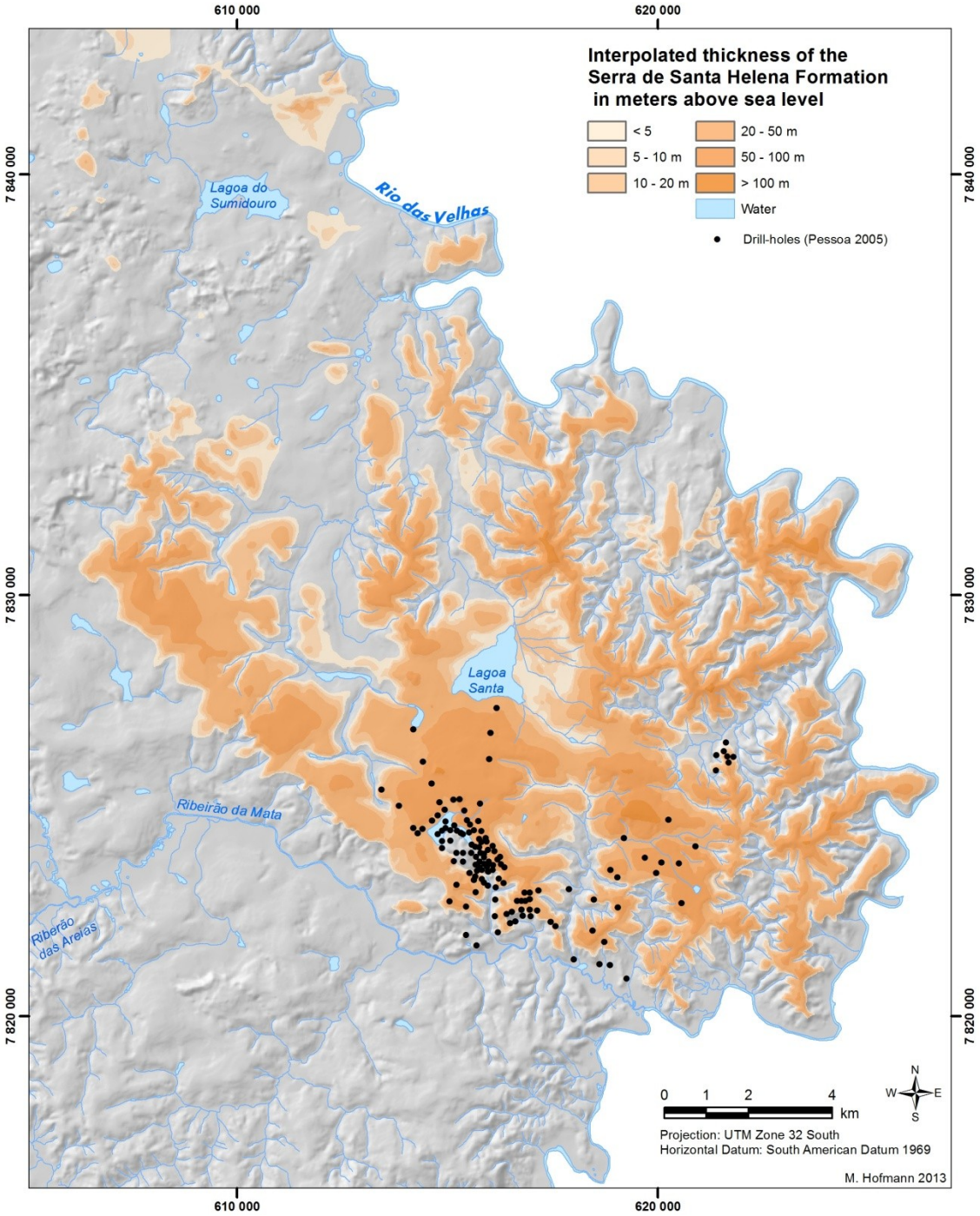
Map 38 Elevation of the basement surface

The map was interpolated from outline and drillhole data (see section 5.9.4). The northern part of the area is higly insecure.



Map 39 Base elevation of the Serra de Santa Helena Formation.

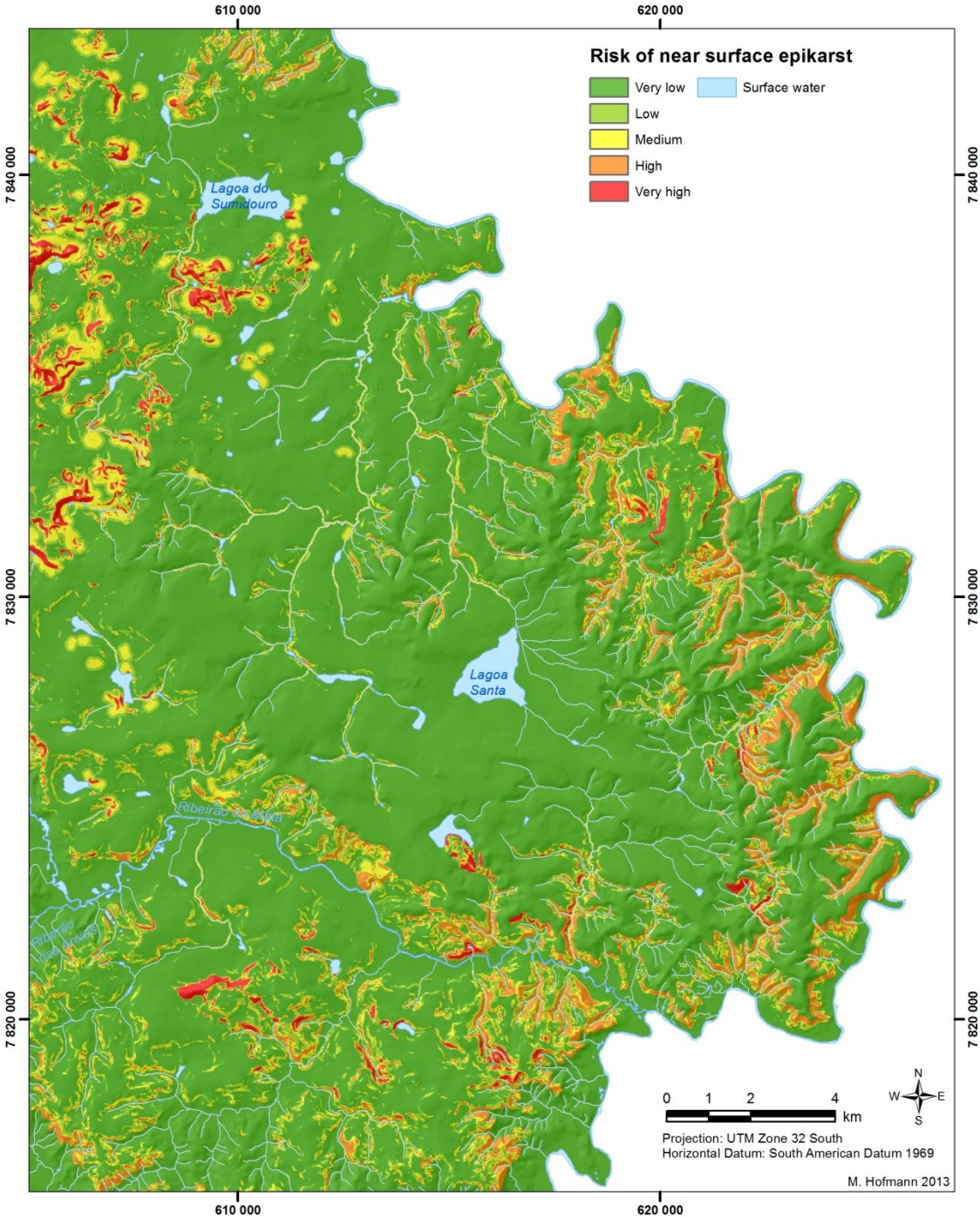
The map was interpolated from outline and drillhole data (see also section 11.3)



Map 40 Thickness of the Serra de Santa Helena Formation.

The map was interpolated from outline and drillhole data (see also section 11.3). The central part of low values is probably due to subsurface dissolution processes in the underlying carbonates.

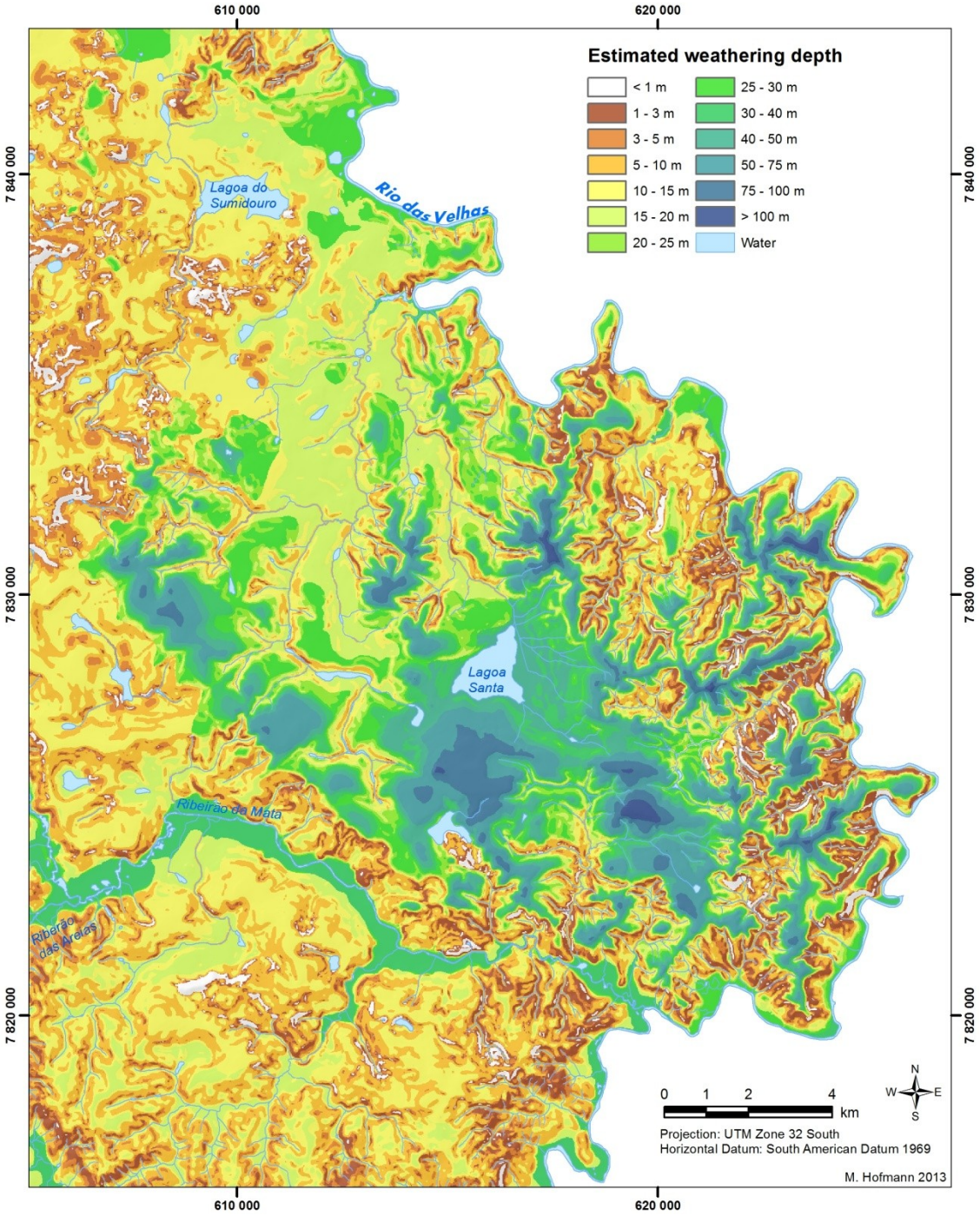
8. Risk of near surface epikarst



Map 41 Regionalized risk for the existence of near surface epikarst.

This value was optimized for the estimation of groundwater vulnerability. The calculation method is described in section 10.5.

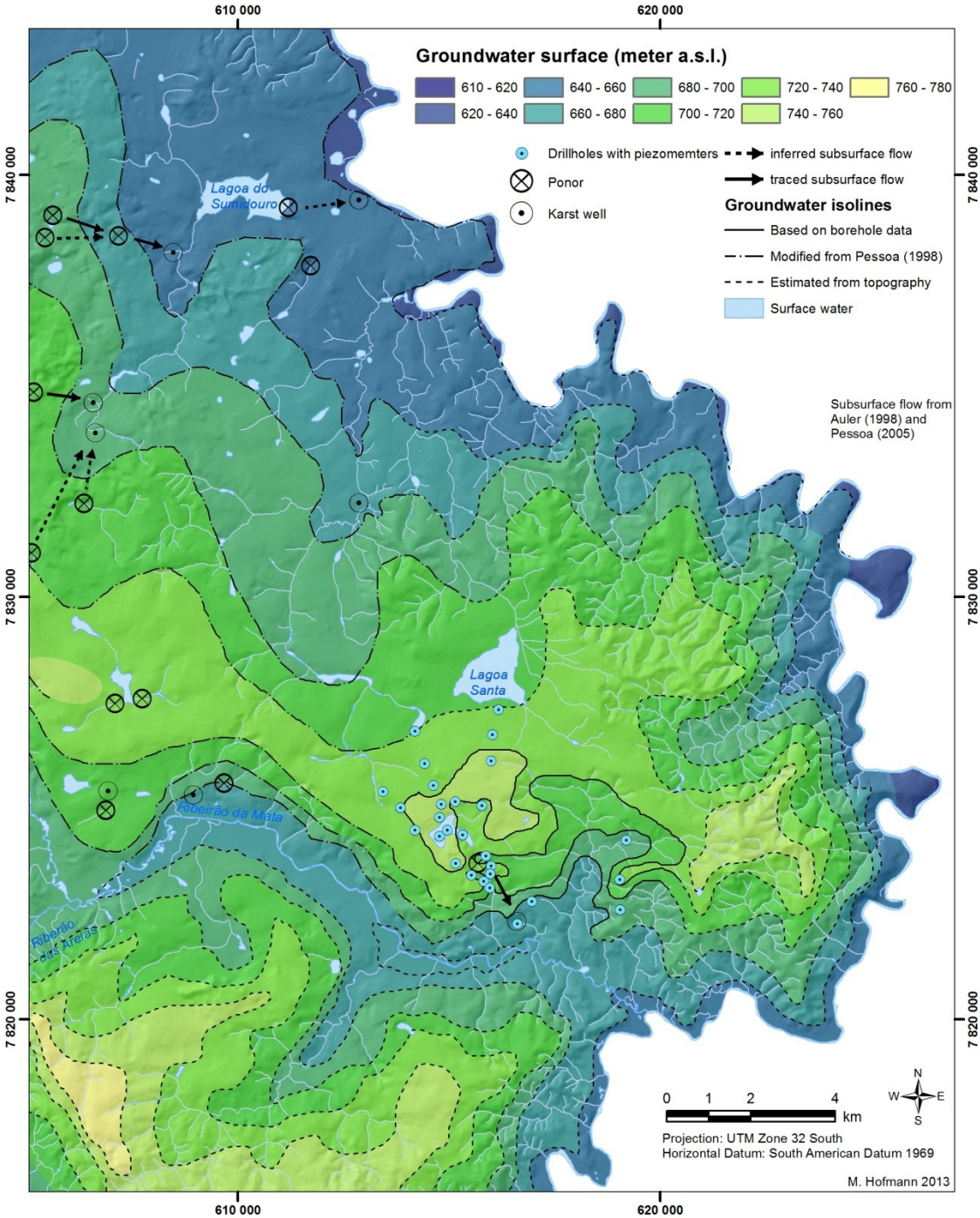
9. Weathering depth



Map 42 Weathering depth.

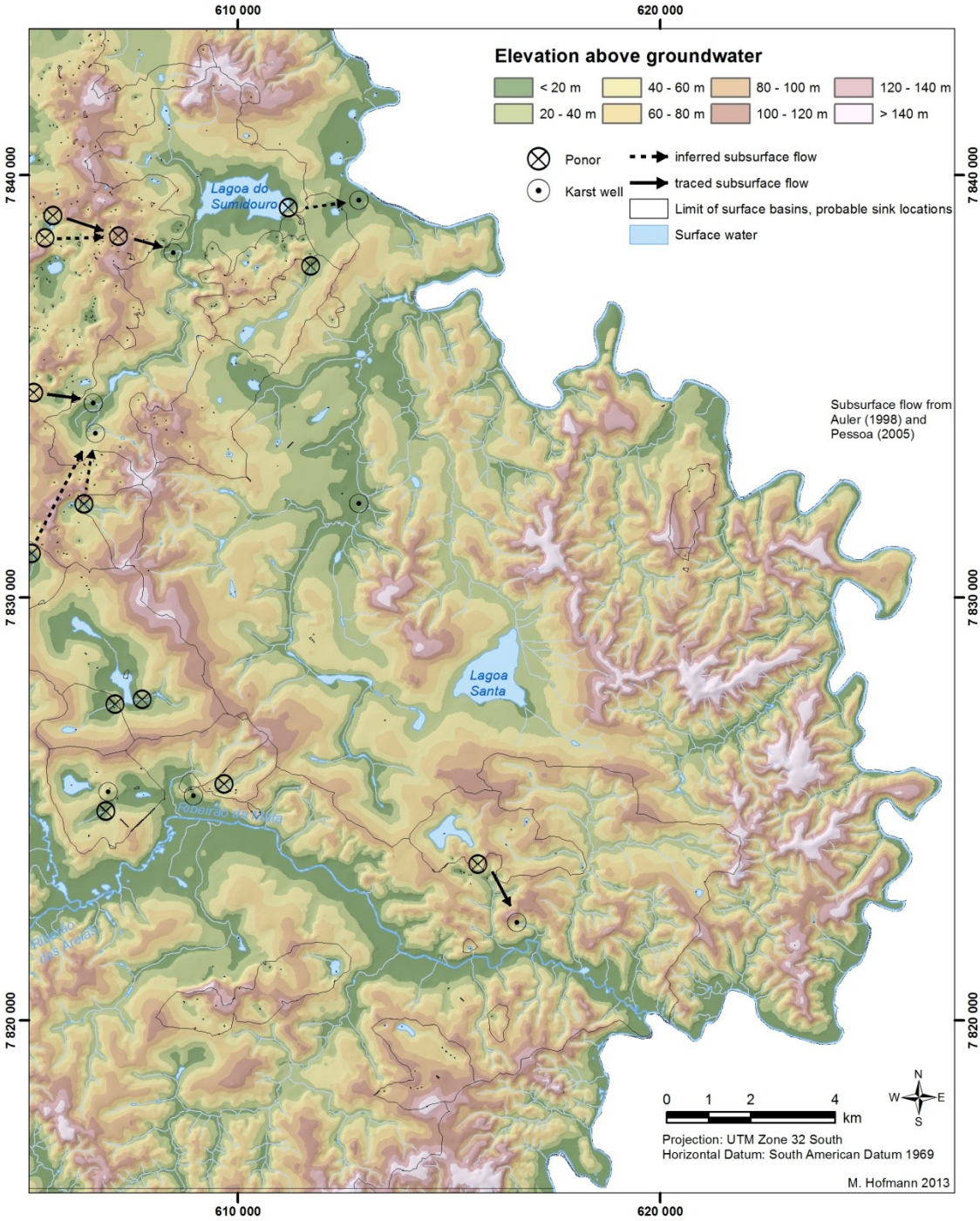
The method is described in section 11.2

10. Geological architecture above groundwater



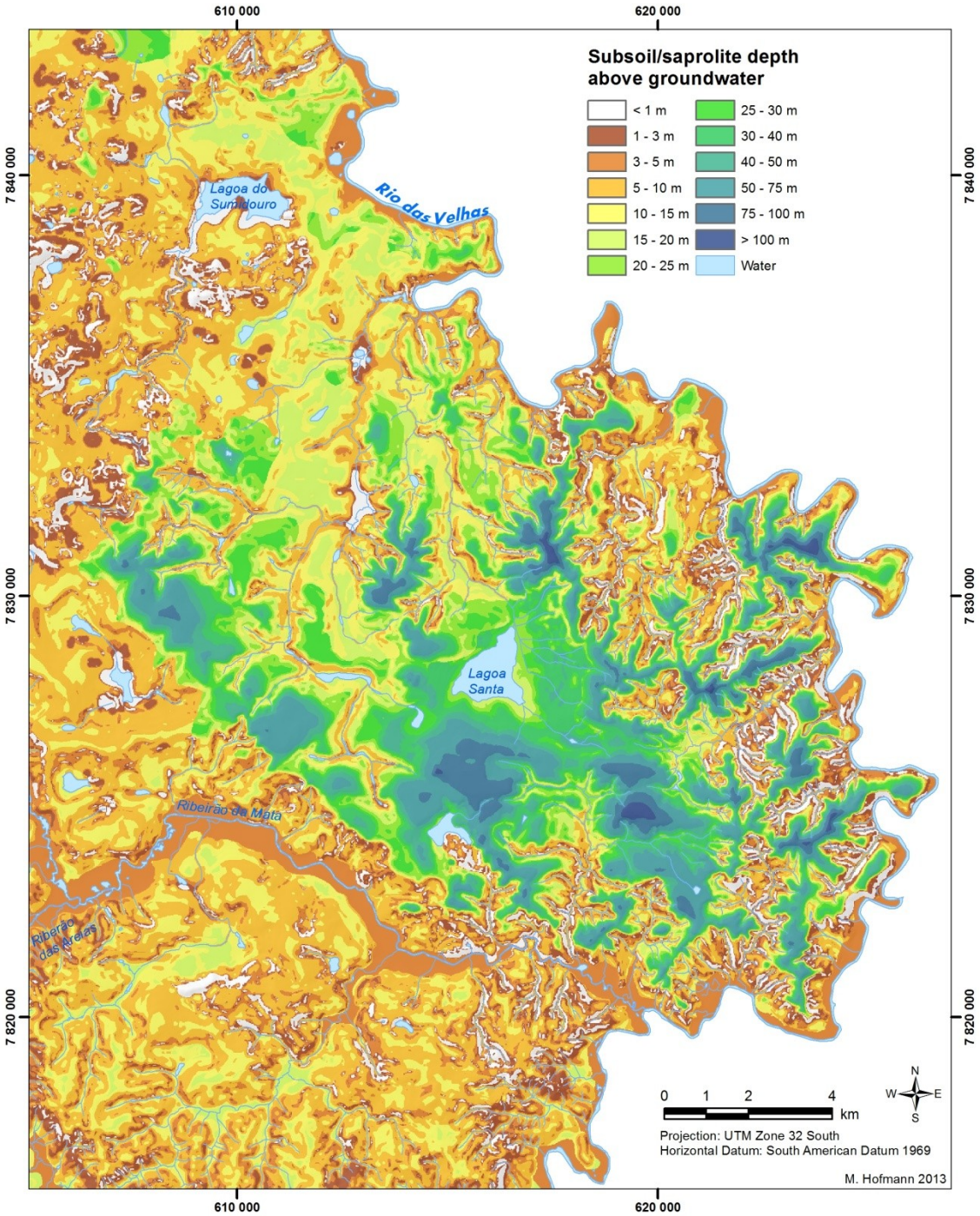
Map 43 Groundwater surface.

The method is described in section 11.1



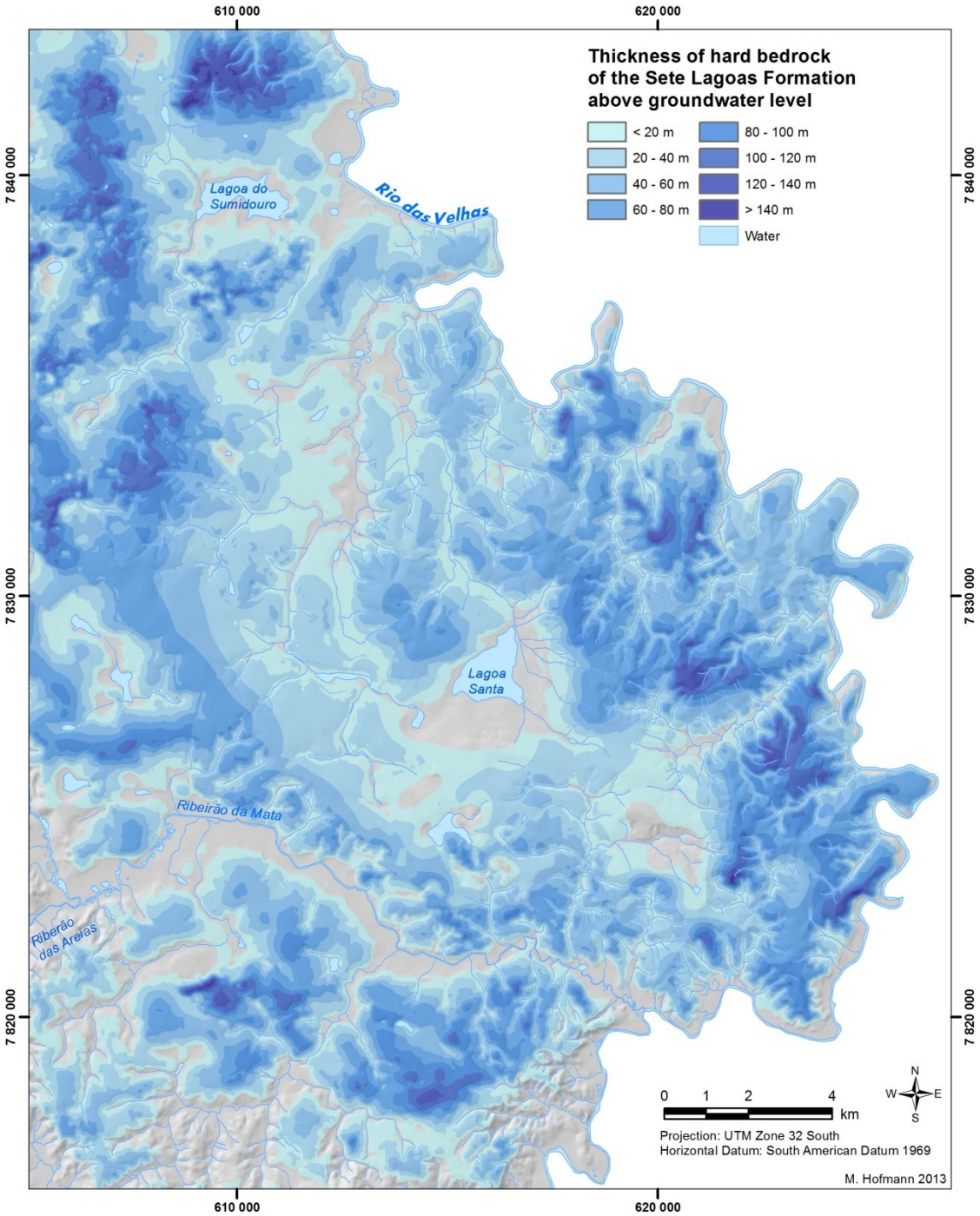
Map 44 Elevation above groundwater.

The method is described in section 11.1



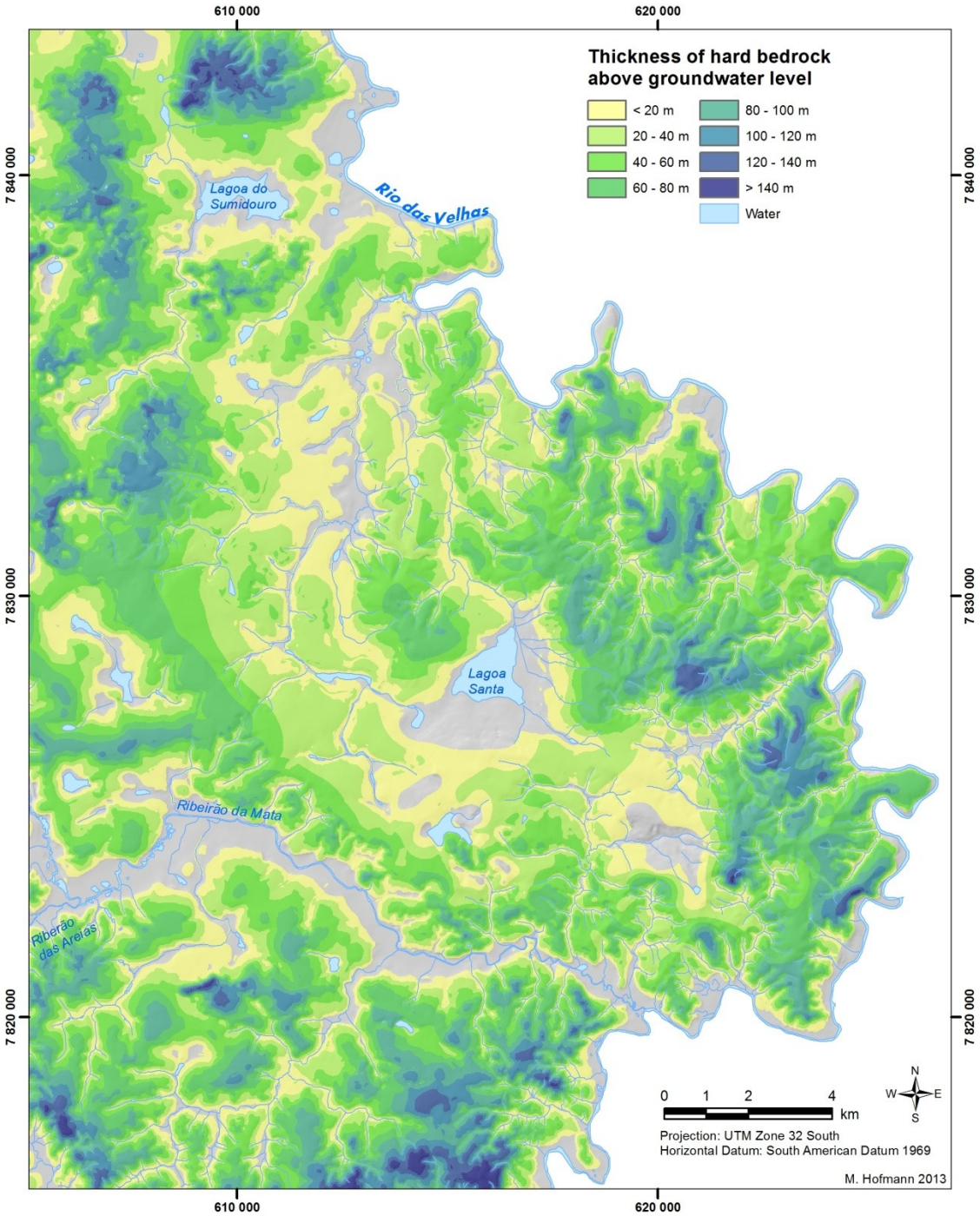
Map 45 Subsoil depth above groundwater.

The method is described in section 11.2.



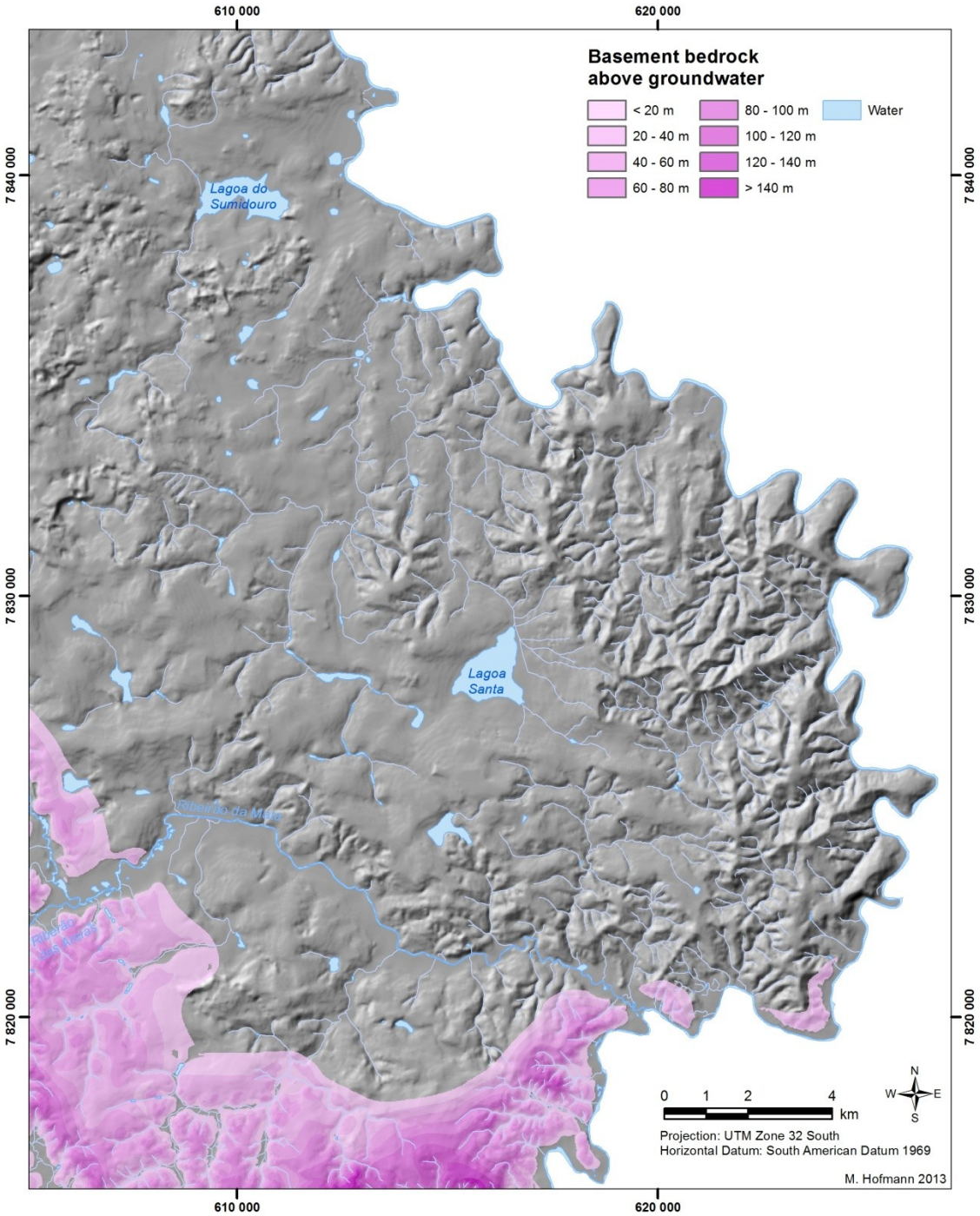
Map 46 Thickness of hard bedrock above groundwater.

The method is described in section 11.4.



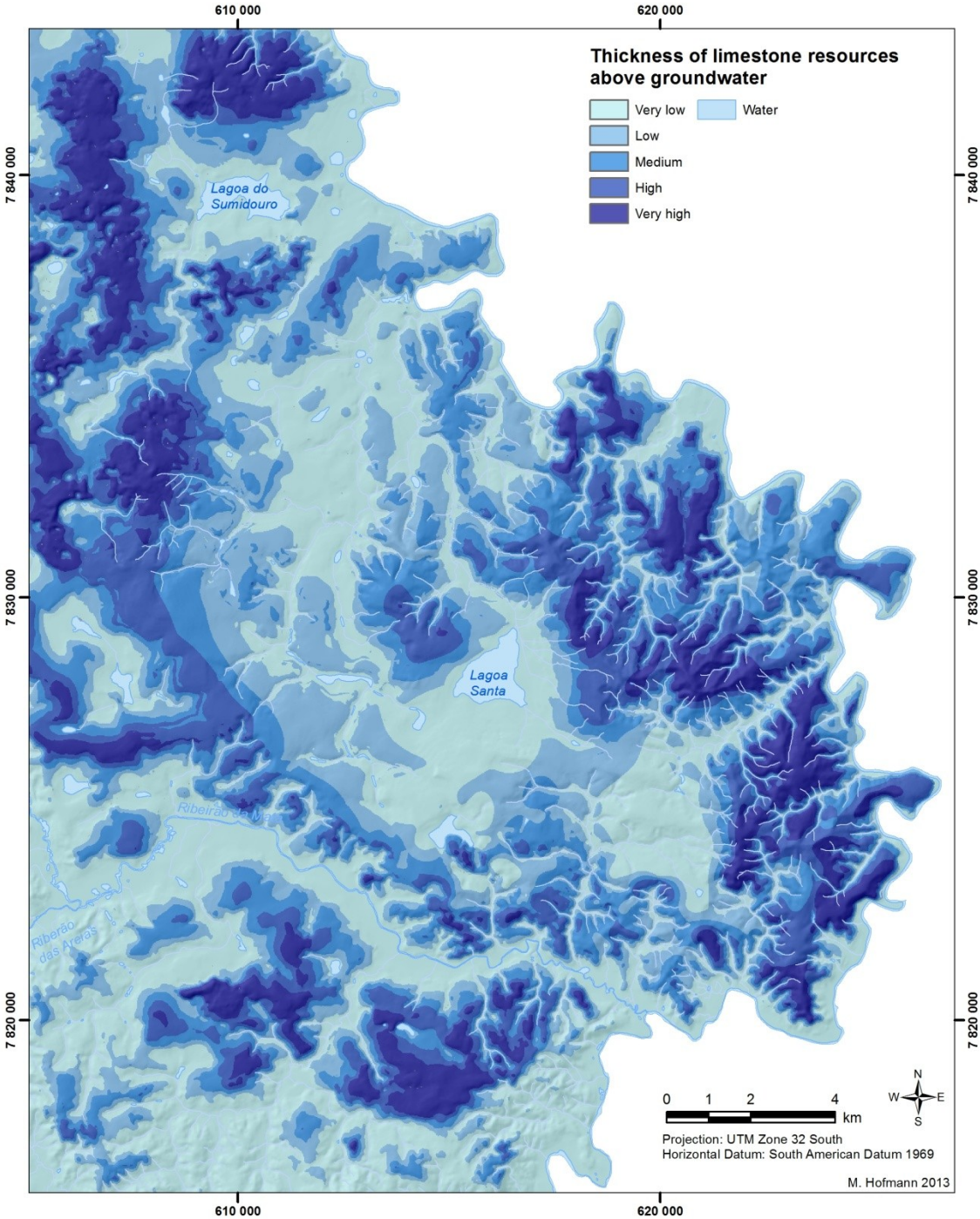
Map 47 Thickness of limestone bedrock above groundwater.

The method is described in section 11.4.



Map 48 Thickness of basement bedrock above groundwater.

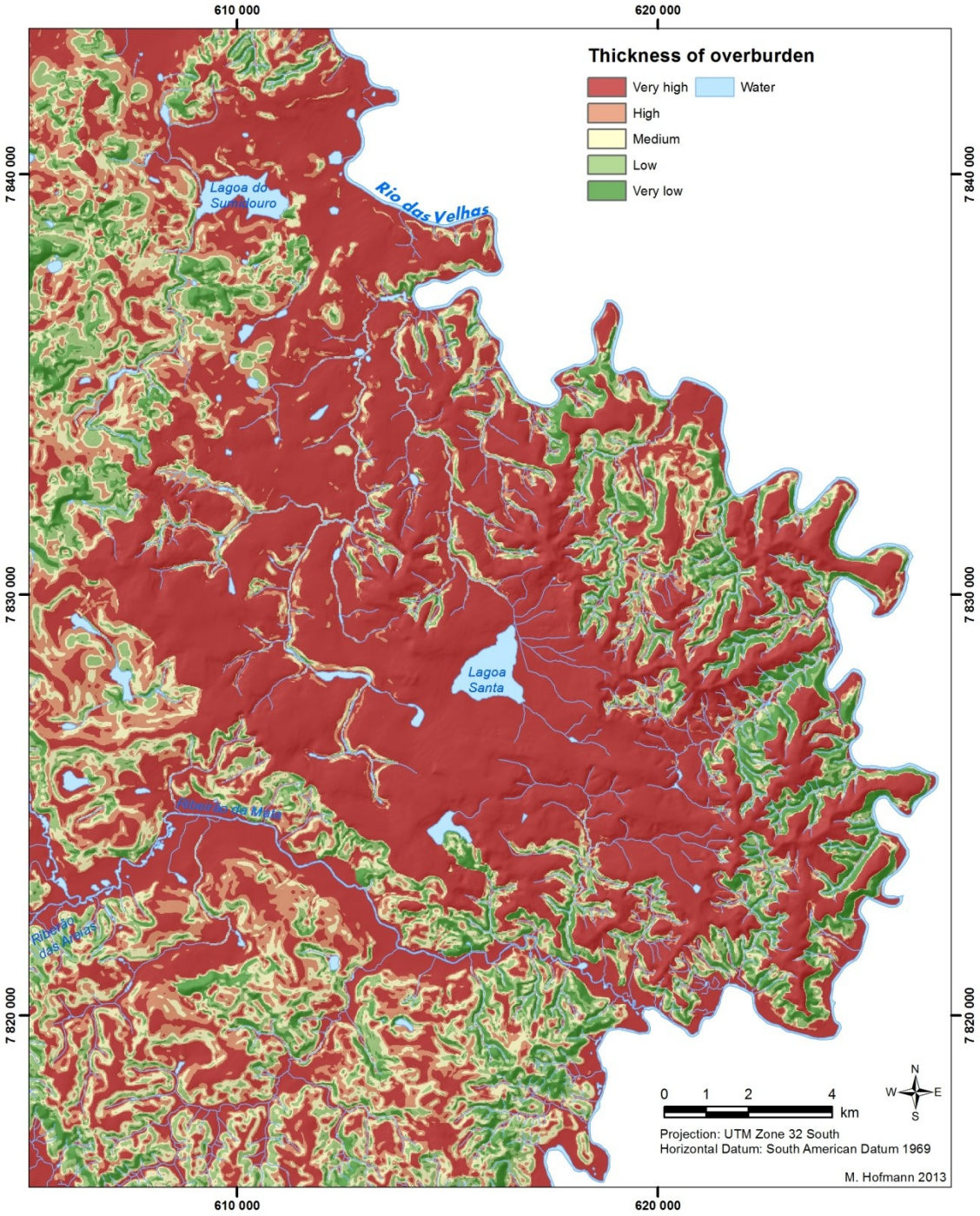
The method is described in section 11.4.



Map 49 Optimality value for limestone thickness above groundwater.

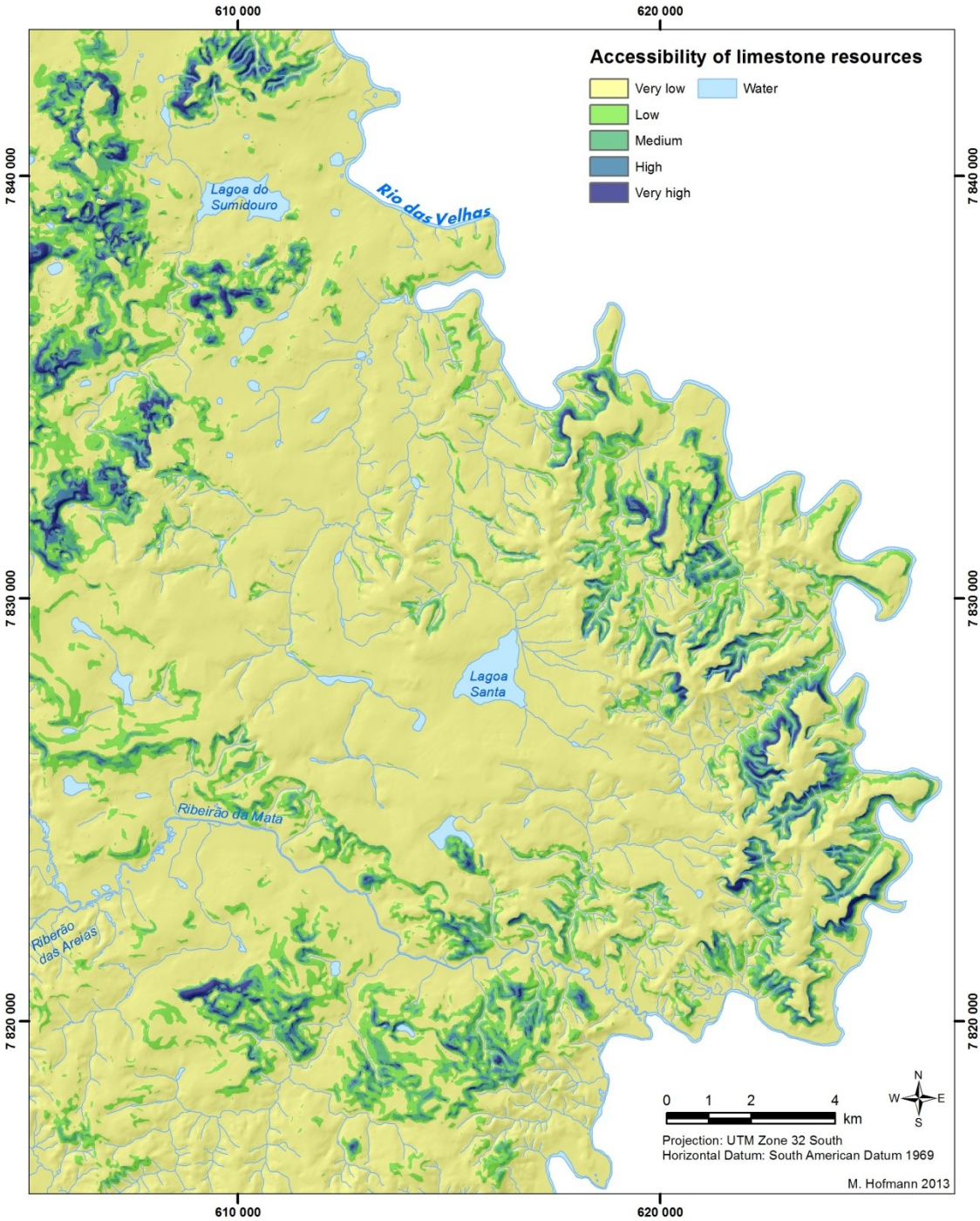
The method is described in section 12.1

11. Mass resources



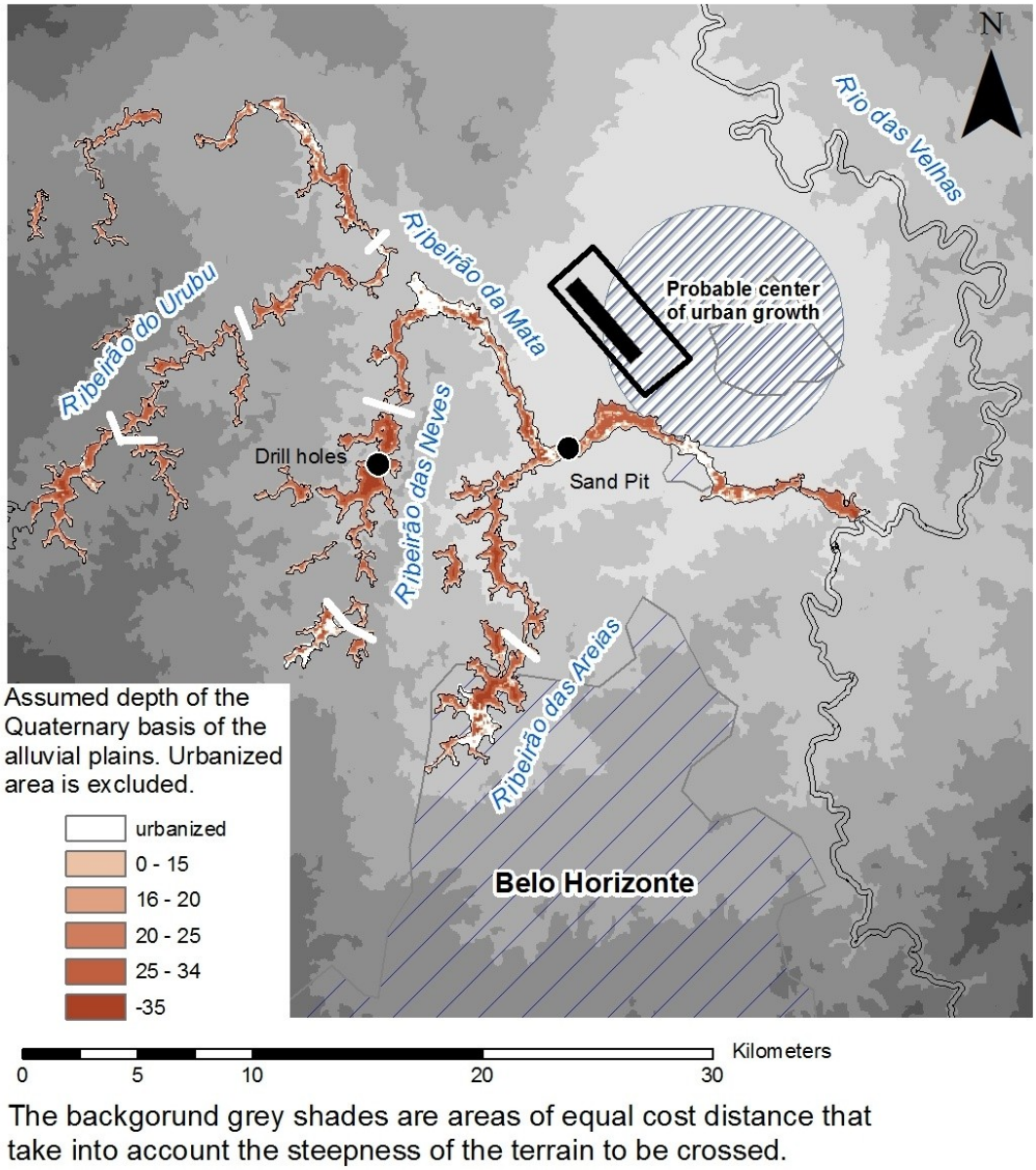
Map 50 Optimality value for overburden above limestone.

The method is described in section 12.1



Map 51 Optimality value for accessibility for limestone resources.

The method is described in section 12.1



The backgorund grey shades are areas of equal cost distance that take into account the steepness of the terrain to be crossed.

Map 52 Sand resources

Assumed depth of the Quaternary sediments in the Riberão da Mata fluvial system around the probable center of urban growth next to the international airpoirt.

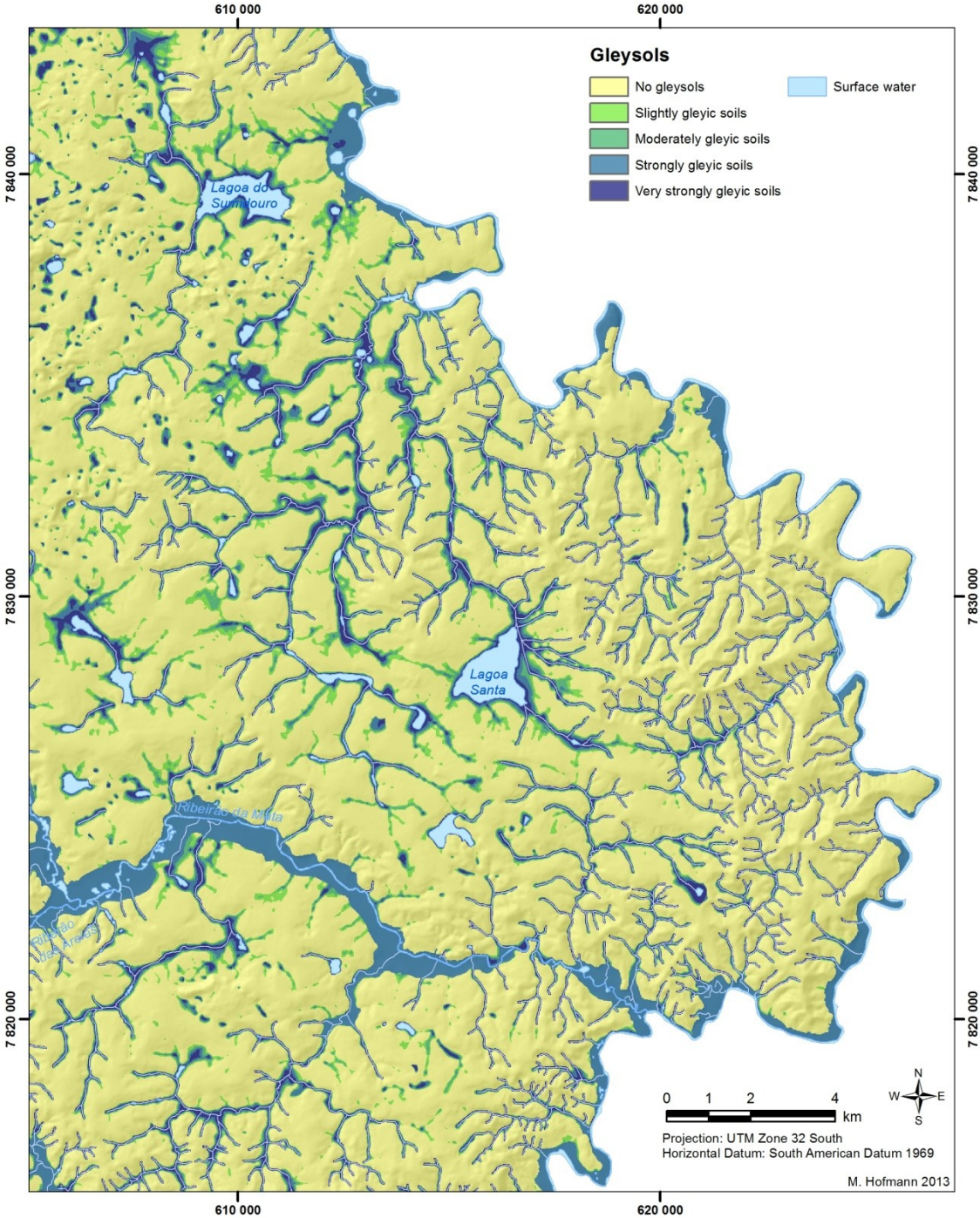
White areas = urbanized areas within the alluvial plains.

Grey areas = equidistant zones of a cost-distance calculation that takes into account the steepness of the terrain.

White bold lines = knick points of the graded river profile (compare Figure 12-2). Hofmann et al. (2009).

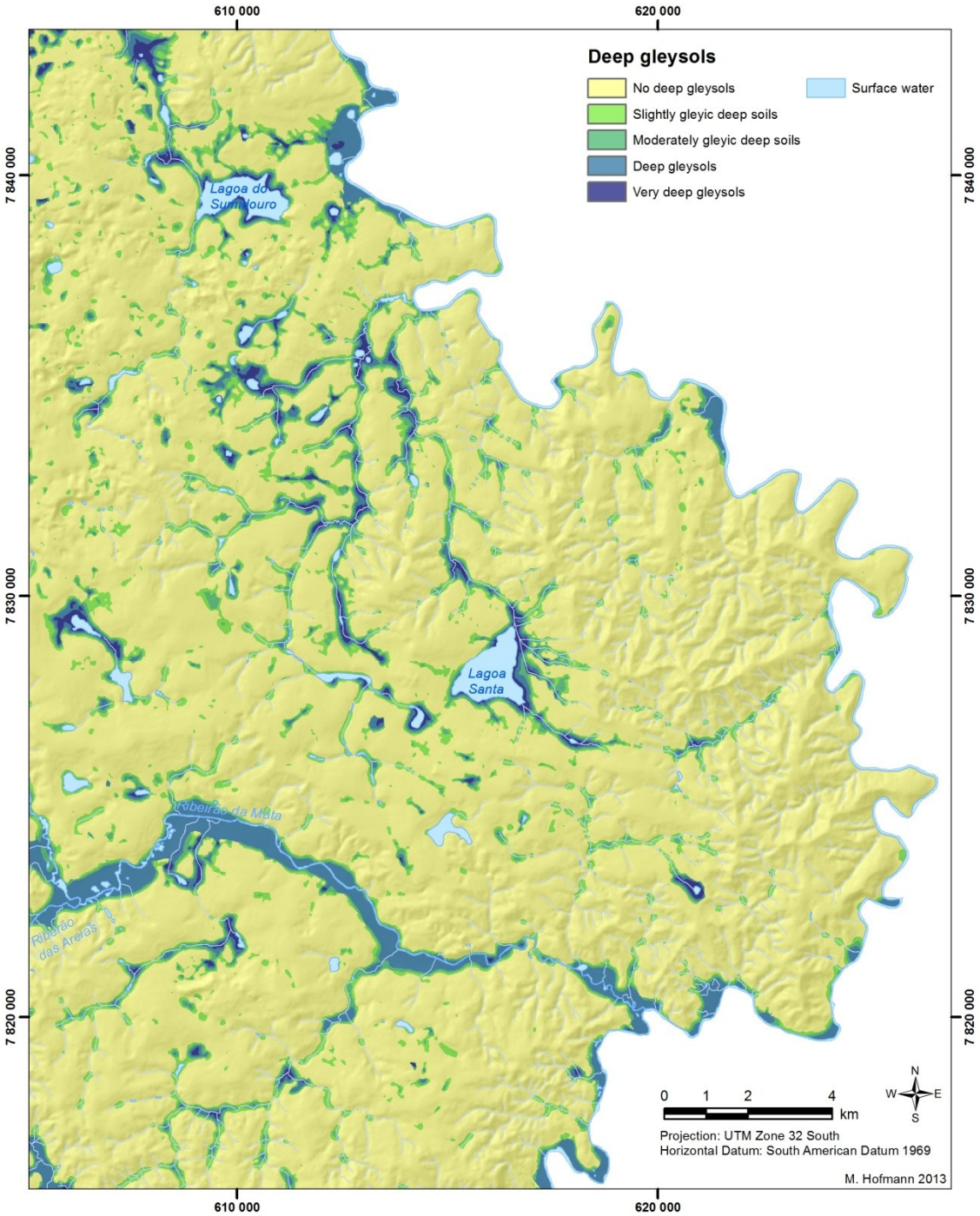
E. Soil properties

1. Soil types



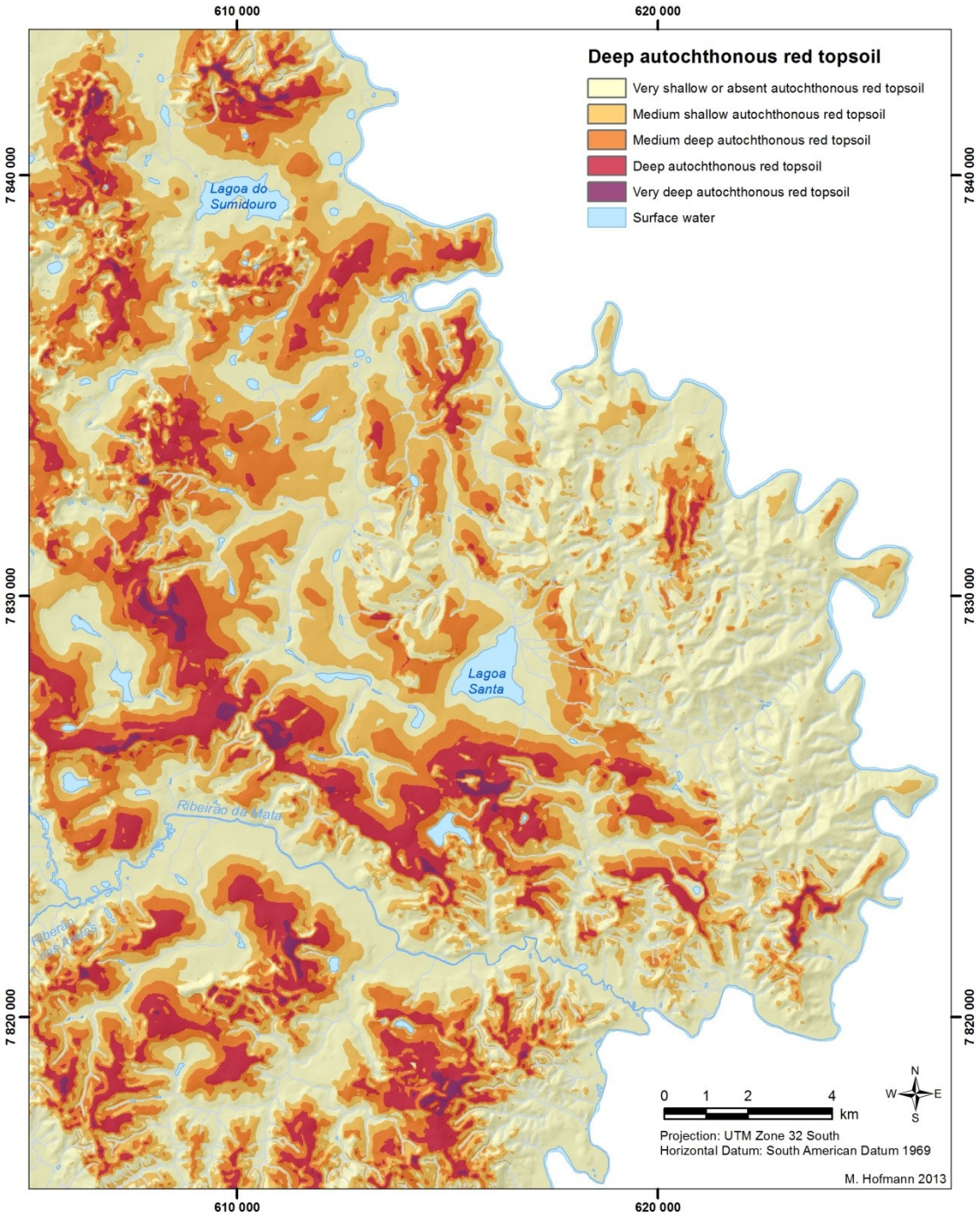
Map 53 Gleysols.

The method is described in section 10.6.2.



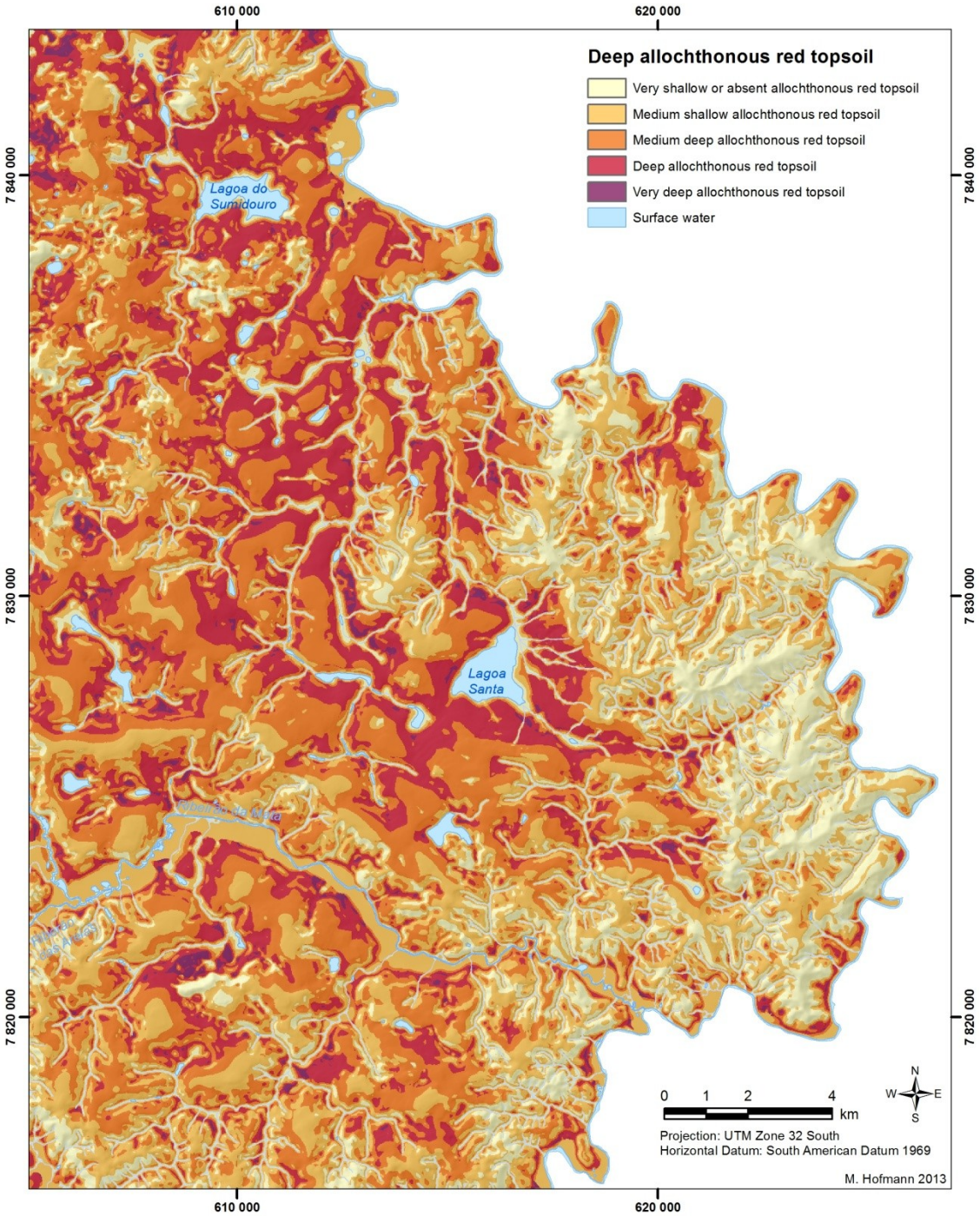
Map 54 Deep Gleysols.

The method is described in section 10.6.2



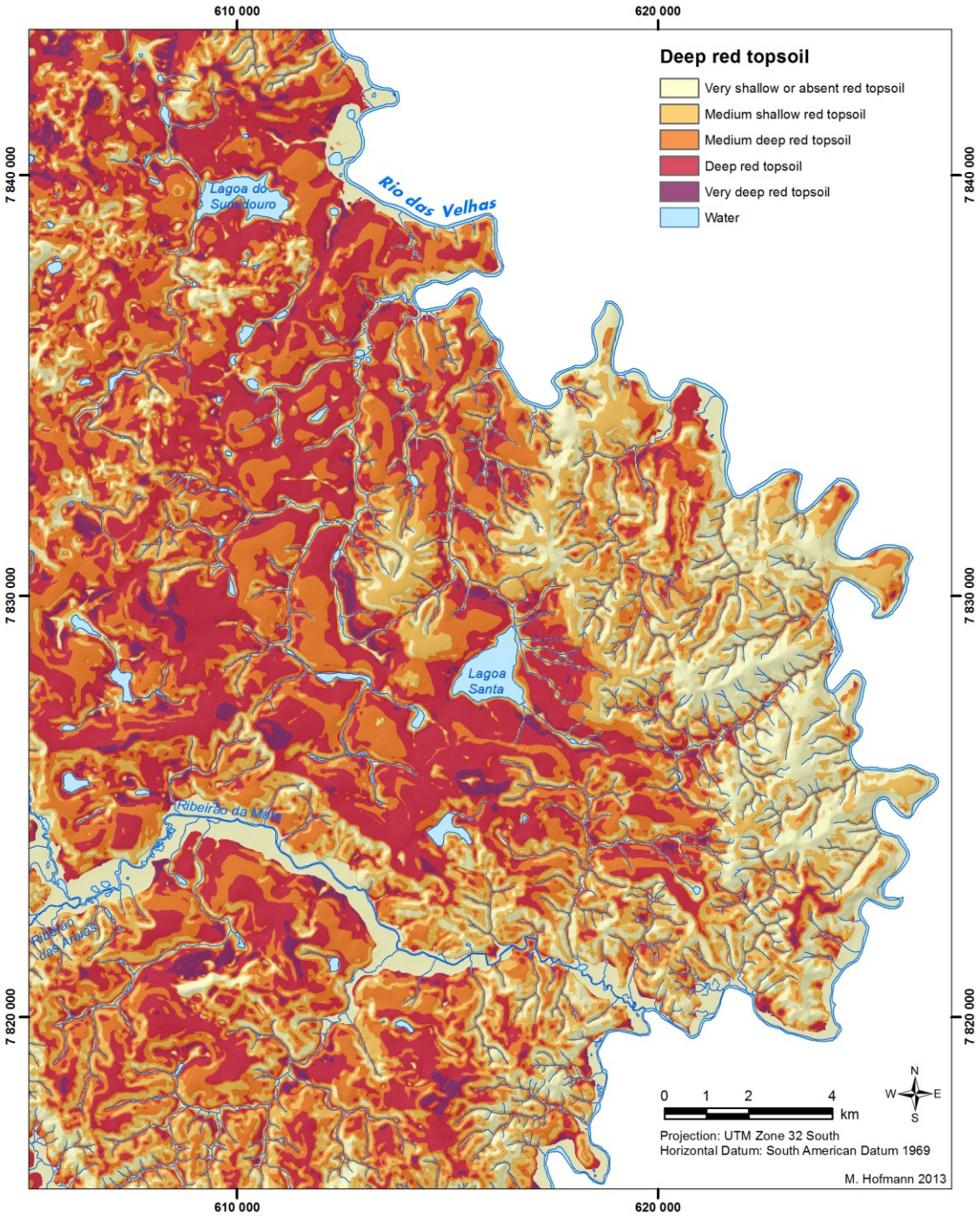
Map 55 Deep autochthonous red topsoil.

The method is described in section 10.6.3.



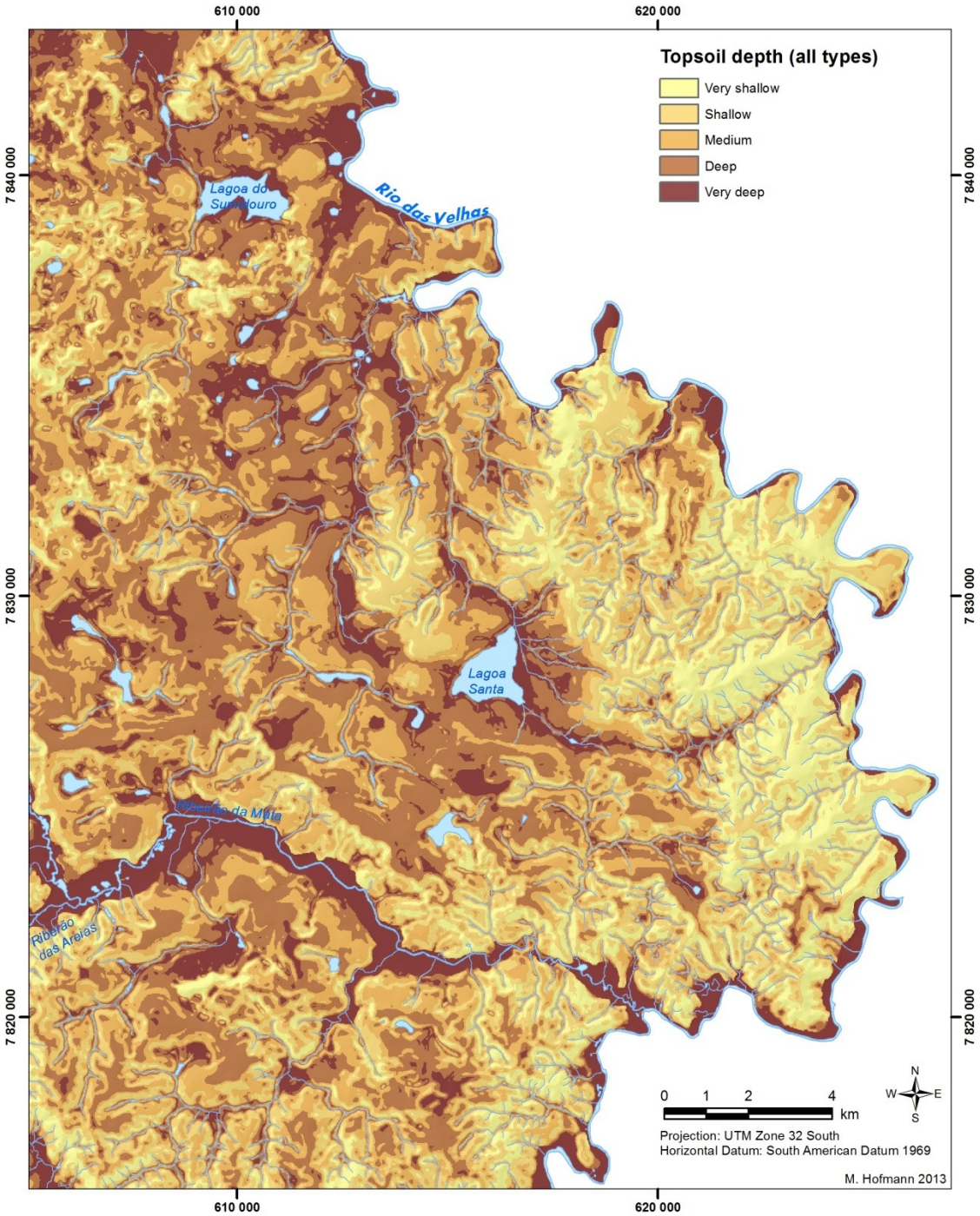
Map 56 Deep allochthonous red topsoil.

The method is described in section 10.6.3.



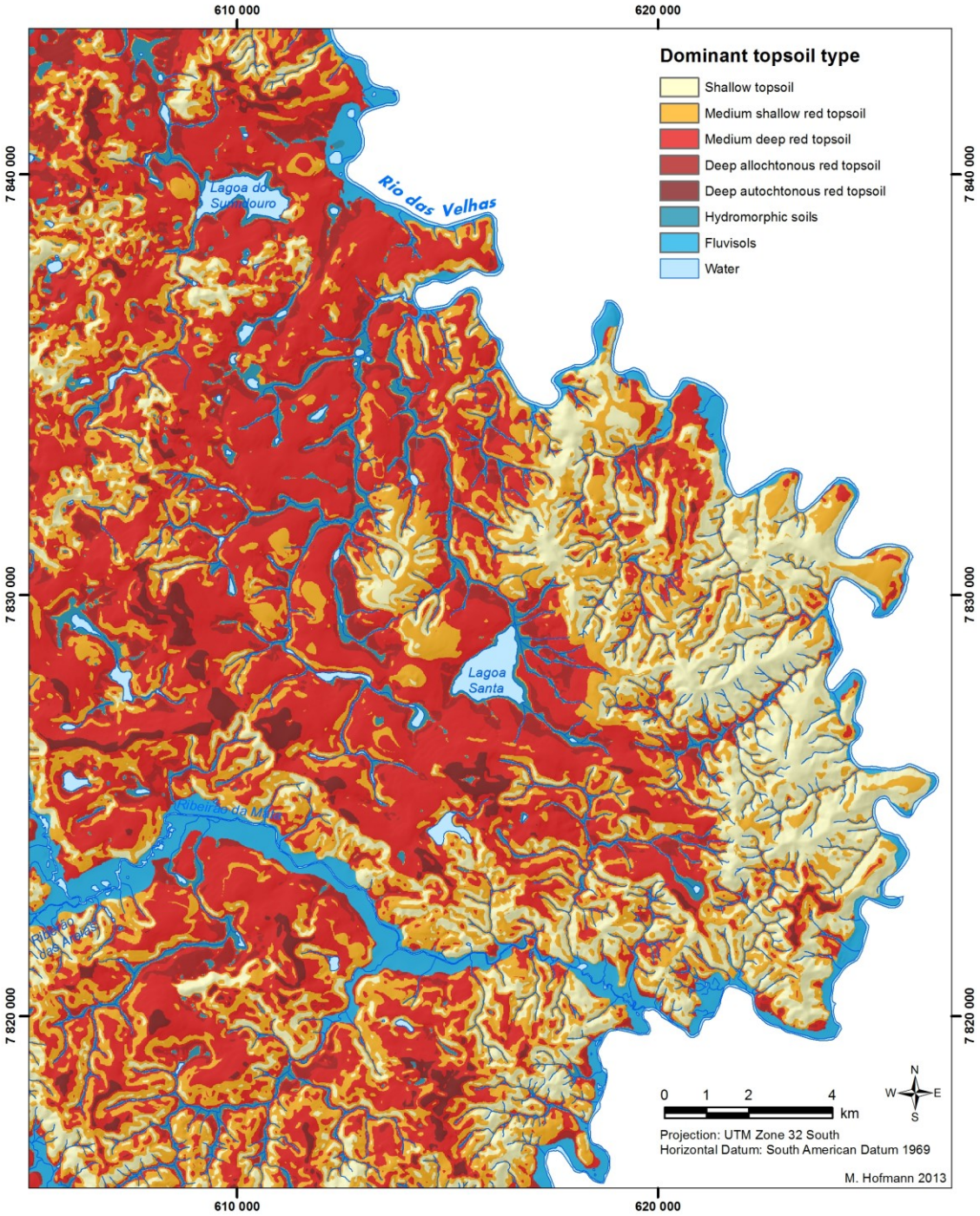
Map 57 Deep red topsoil.

The method is described in section 10.6.3.



Map 58 Deep all topsoil.

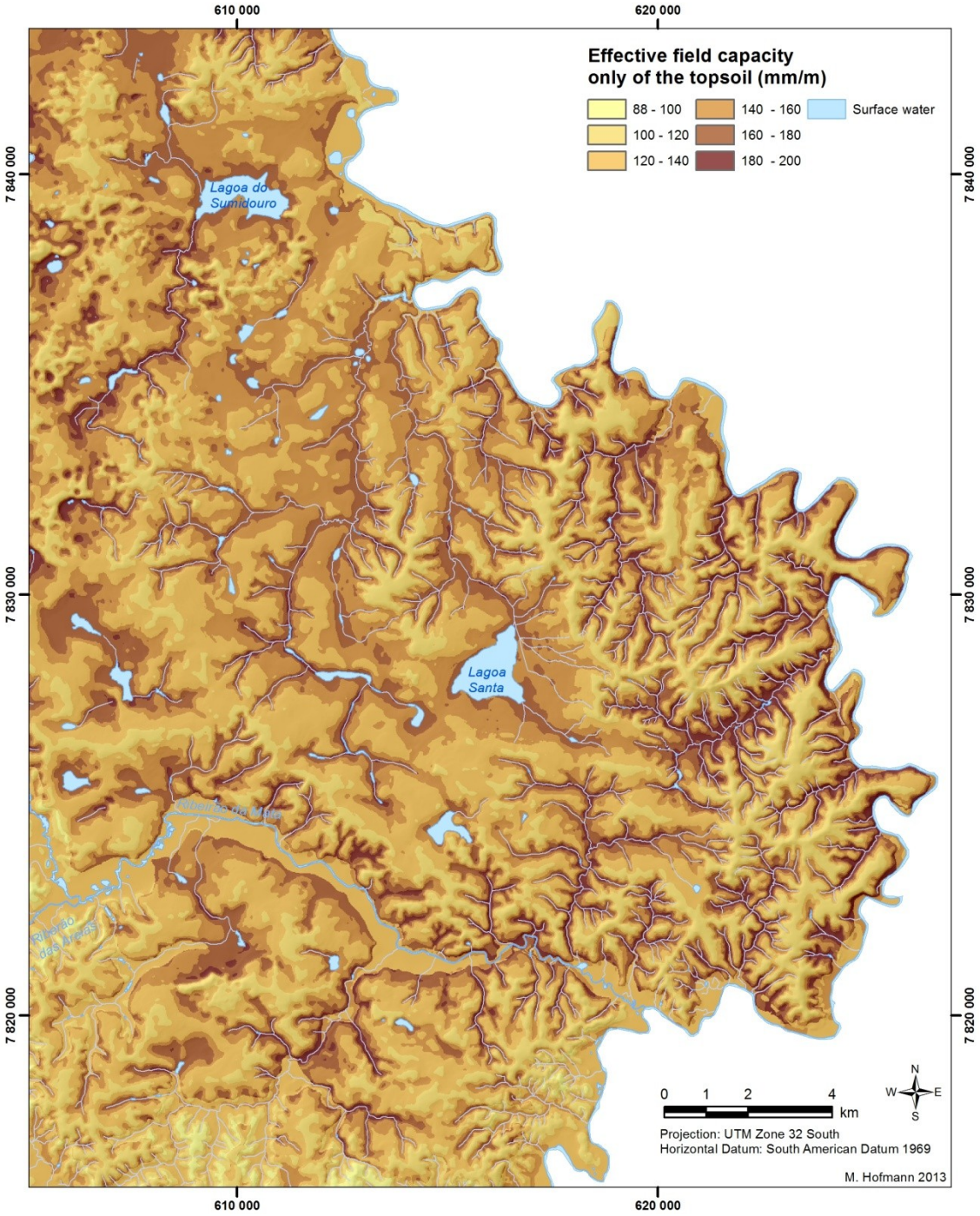
The method is described in section 10.6.3.



Map 59 Dominant hydrological soil type.

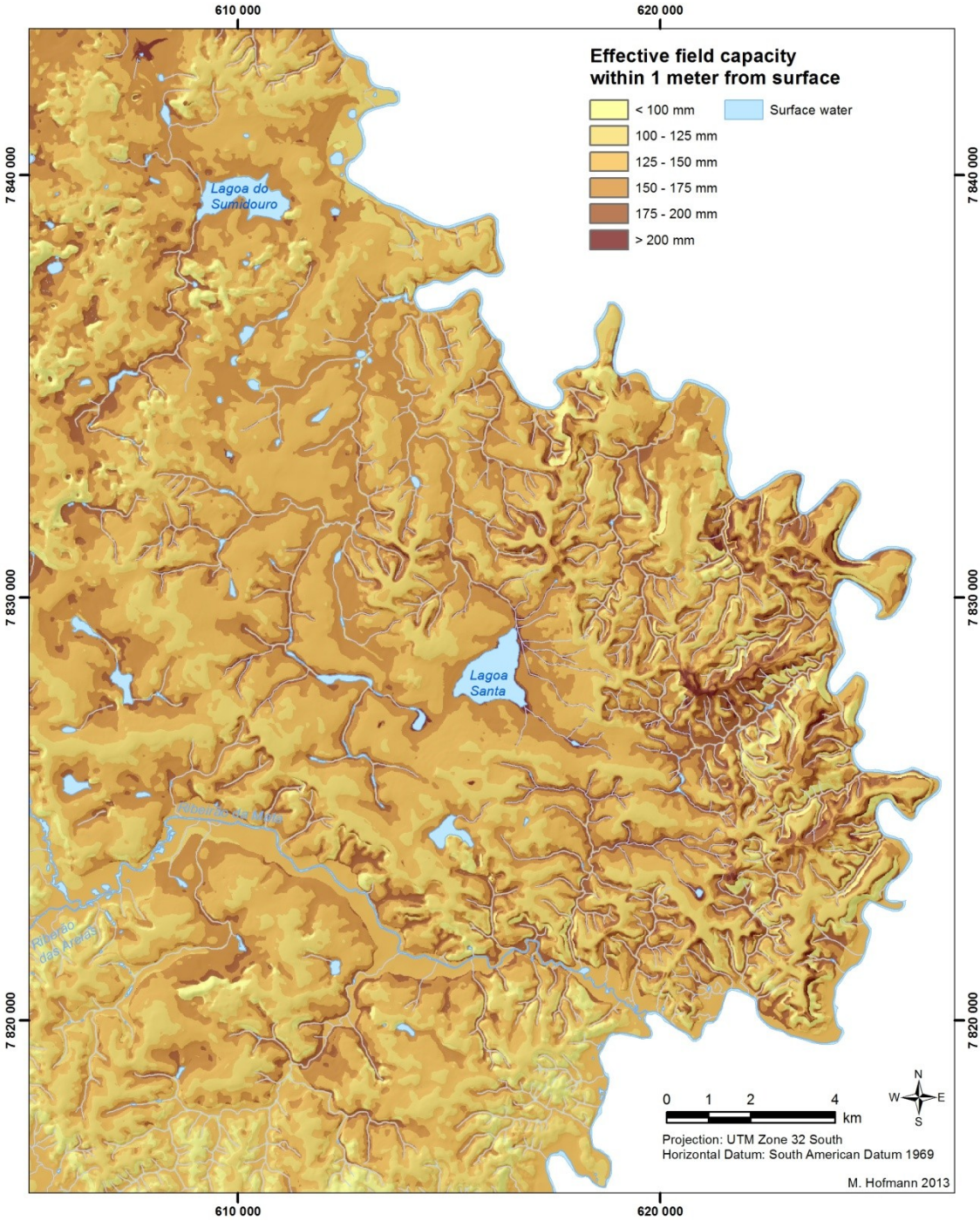
The method is described in section 10.7.

2. Effective field capacity



Map 60 Effective field capacity of the topsoil.

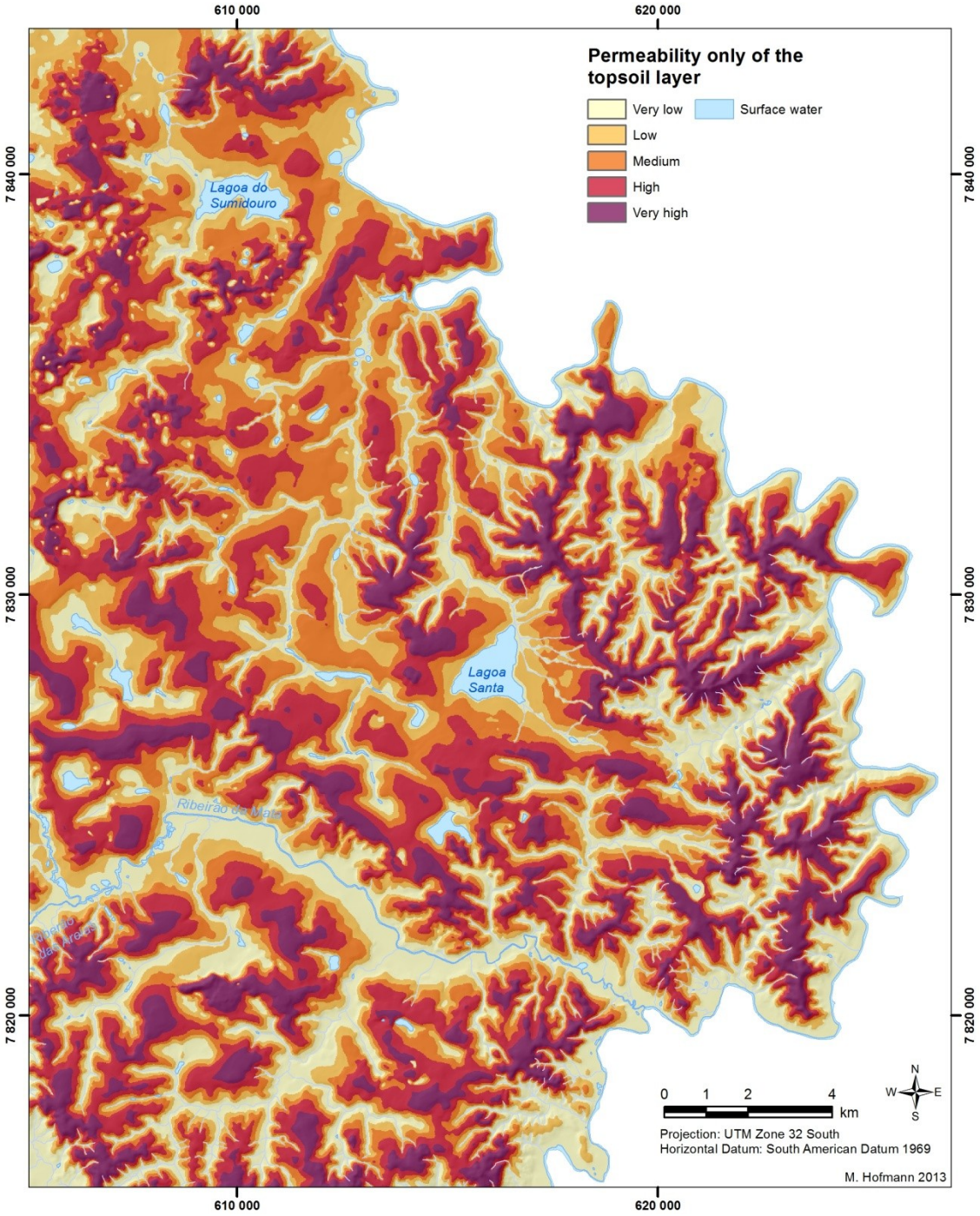
The method is described in section 10.8.



Map 61 Effective field capacity within 1 meter from surface.

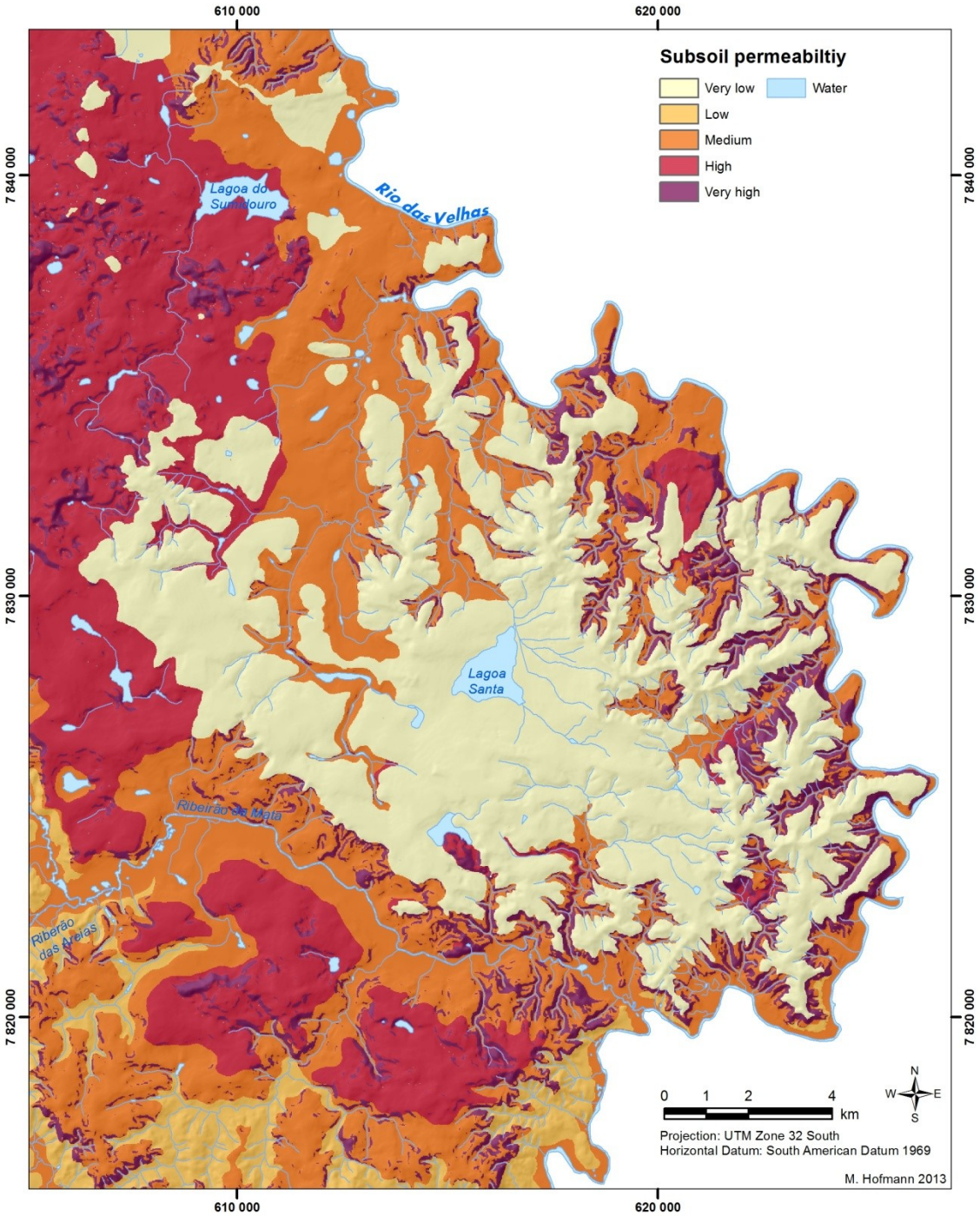
The method is described in section 10.8.

3. Permeability and hydrological categories



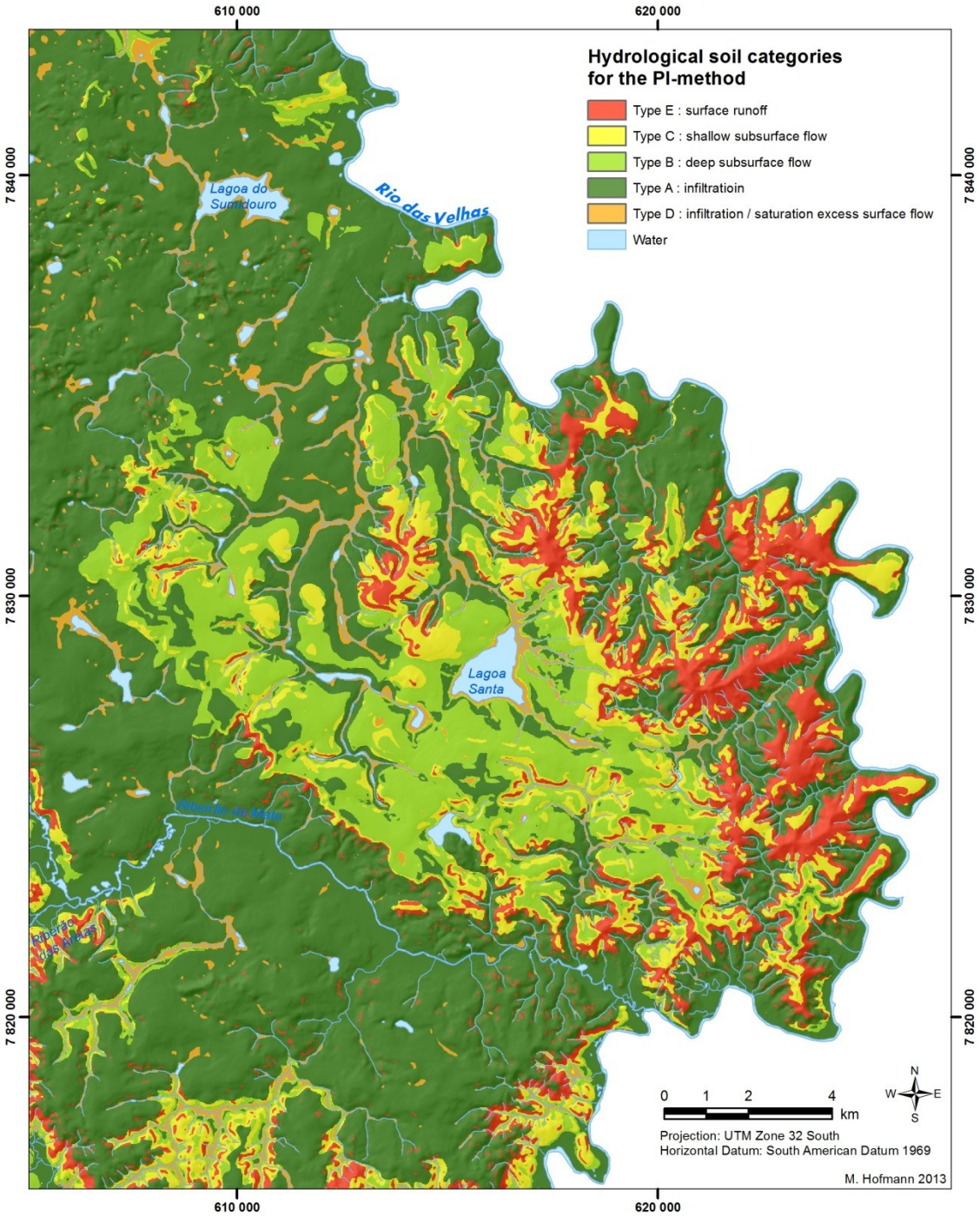
Map 62 Topsoil permeability.

The method is described in section 10.9.1



Map 63 Subsoil permeability

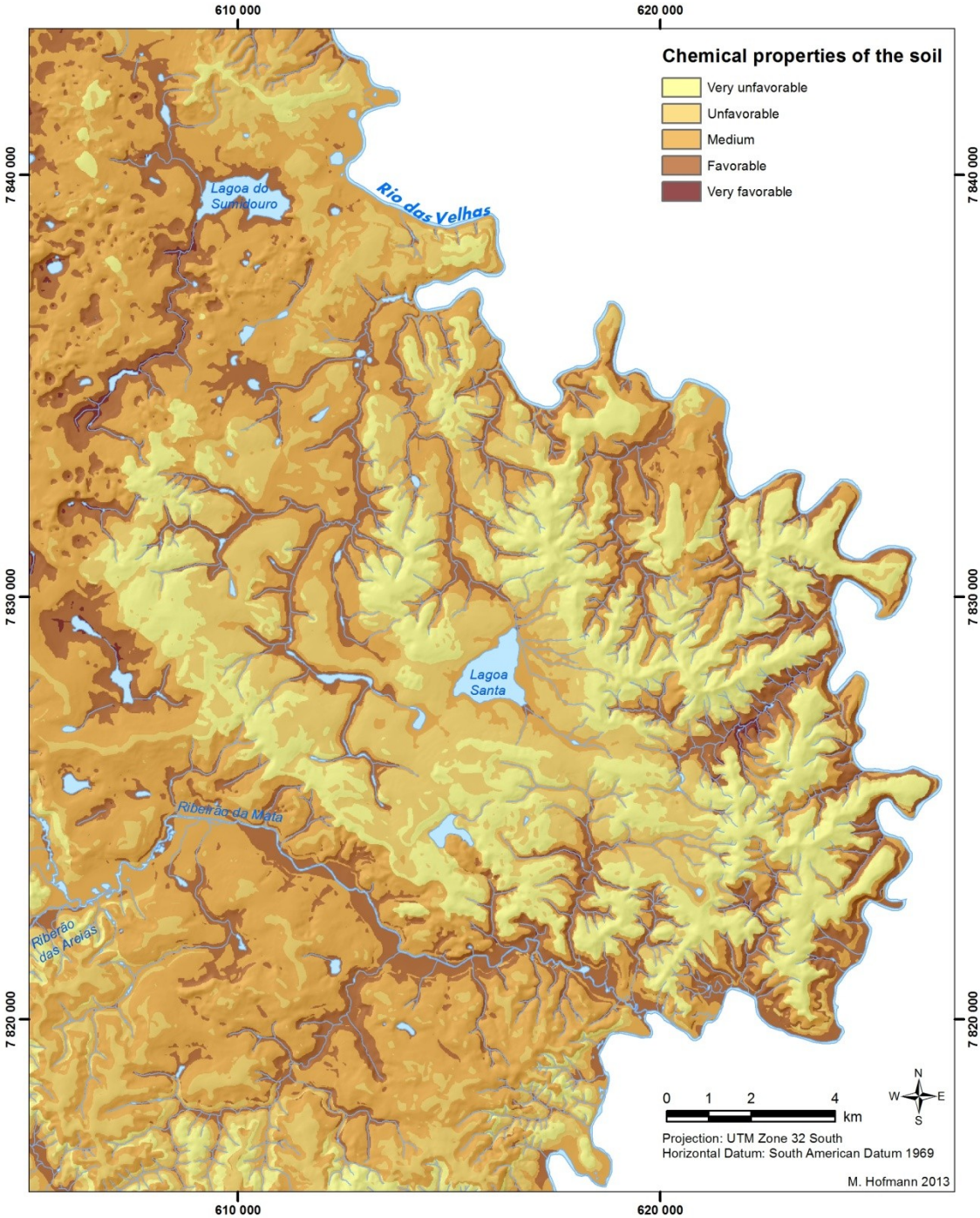
The map is estimated from lithology and risk of near surface epikarst. See section 10.9.2.



Map 64 Hydrological soil categories for dominant flow processes.

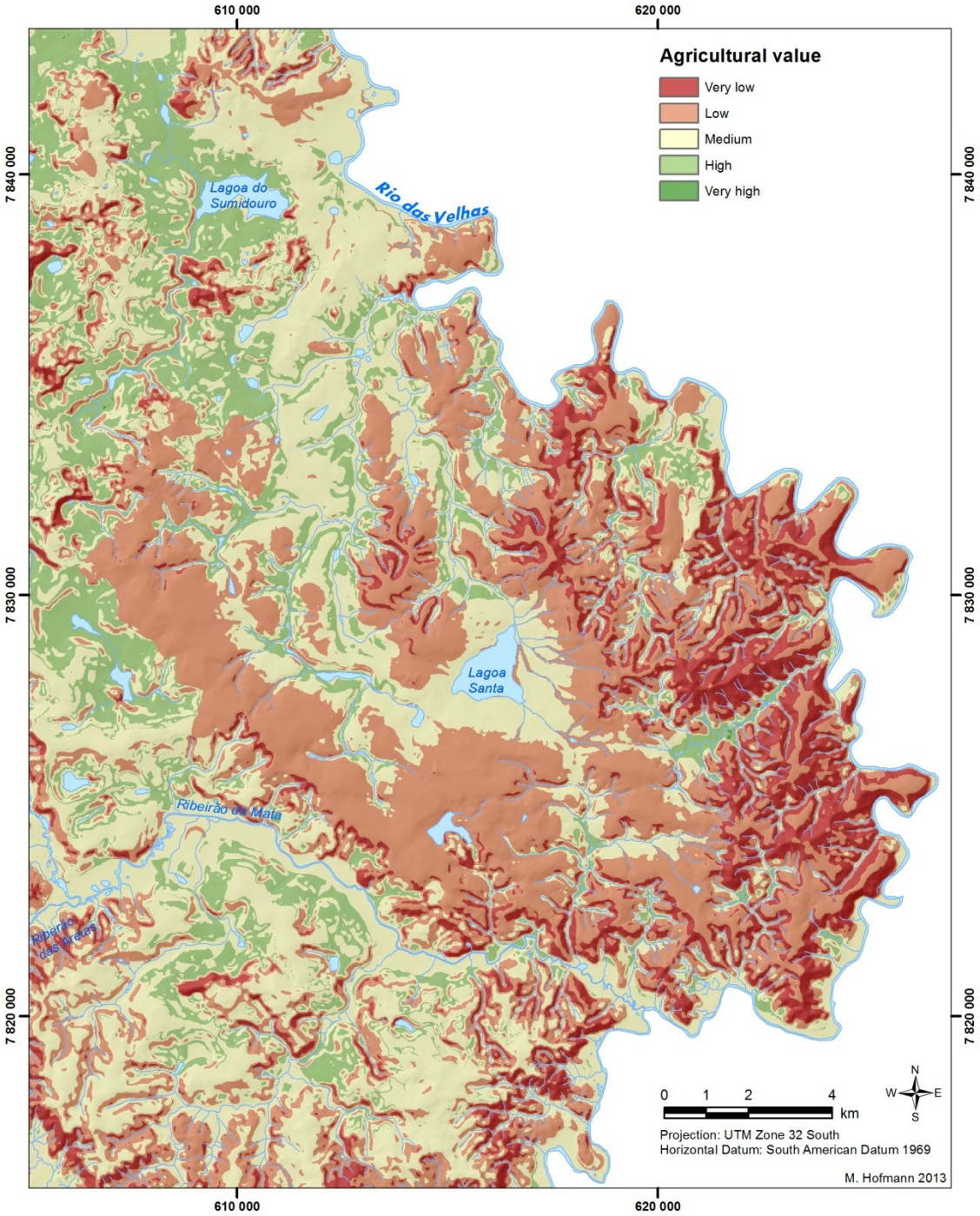
The method is described in section 10.10.

4. Agricultural value



Map 65 Chemical soil properties.

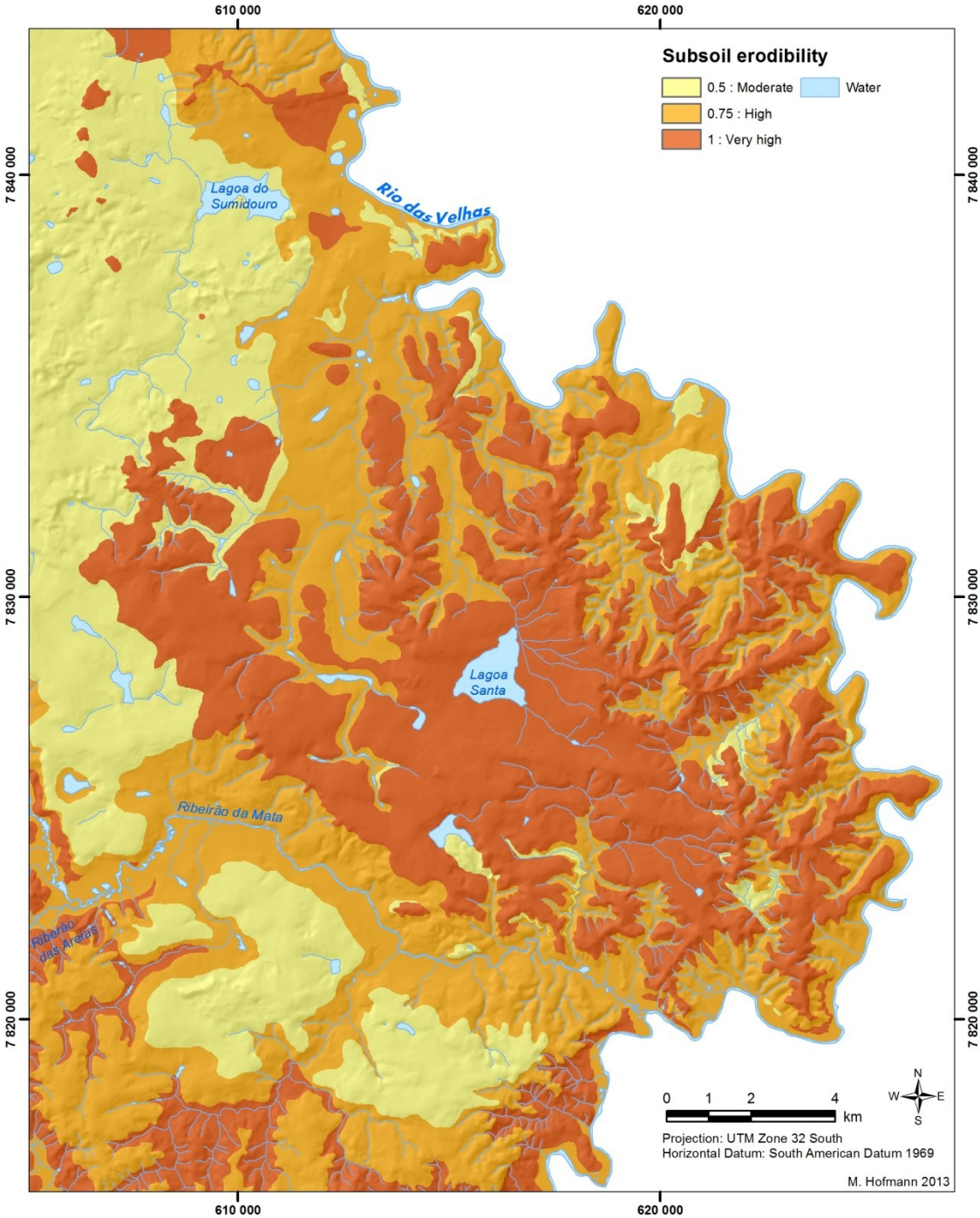
The method is described in section 12.3.1.



Map 66 Agricultural value.

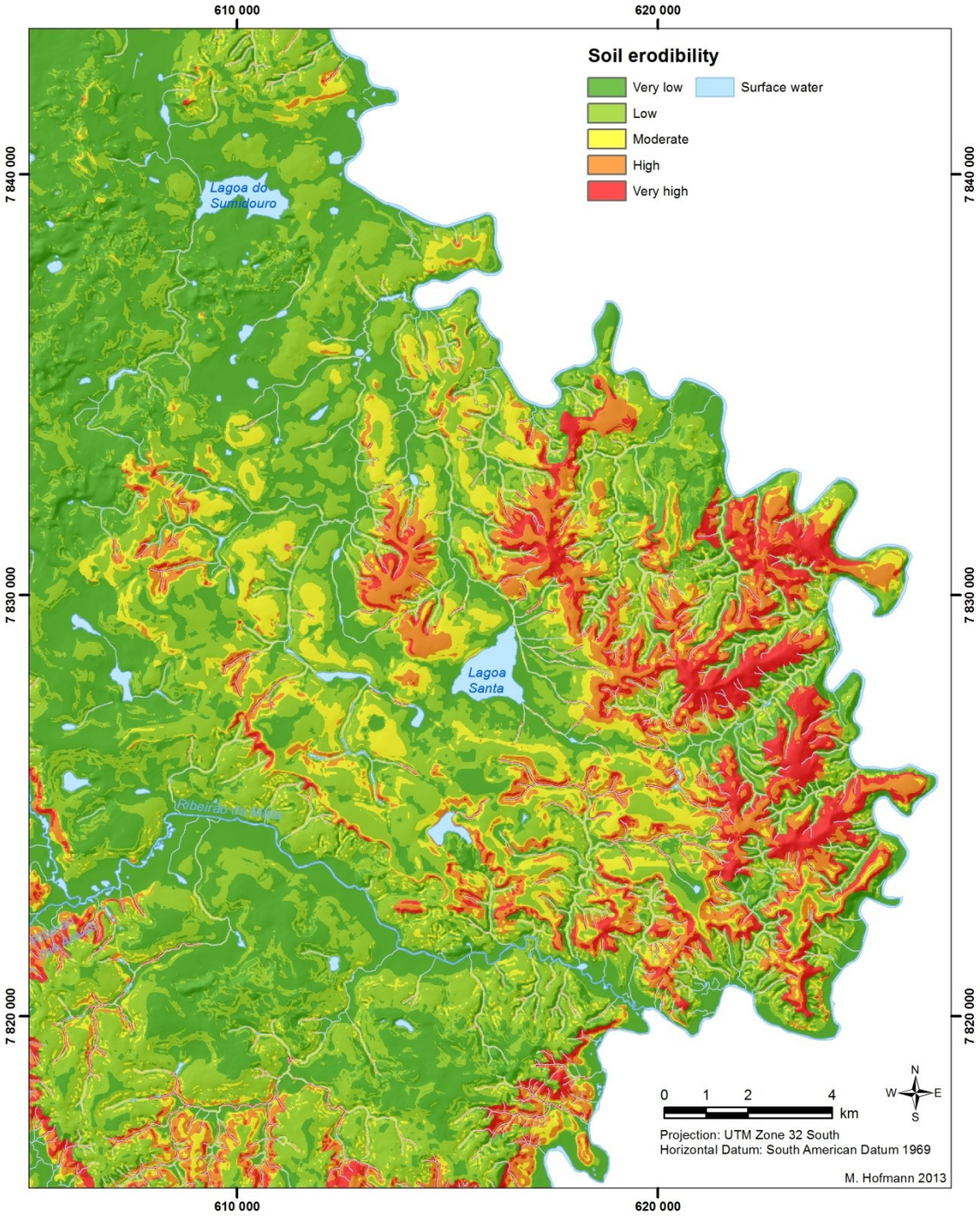
The method is described in section 12.3.2.

5. Erodibility



Map 67 Subsoil erodibility

The values are estimated from geology in comparison with erodibility of the topsoil. See also section 10.11.

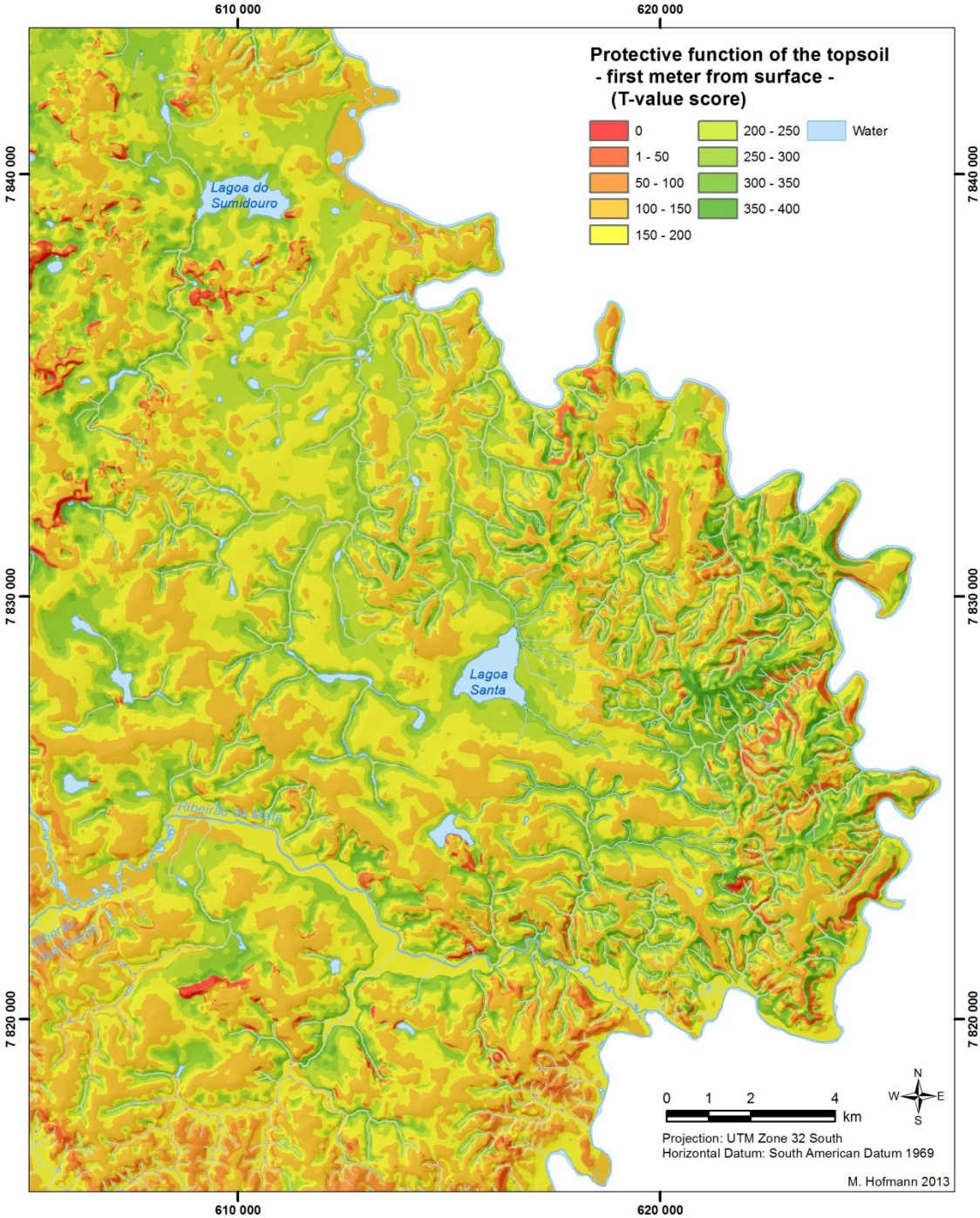


Map 68 Soil erodibility.

The method is described in section 10.11.

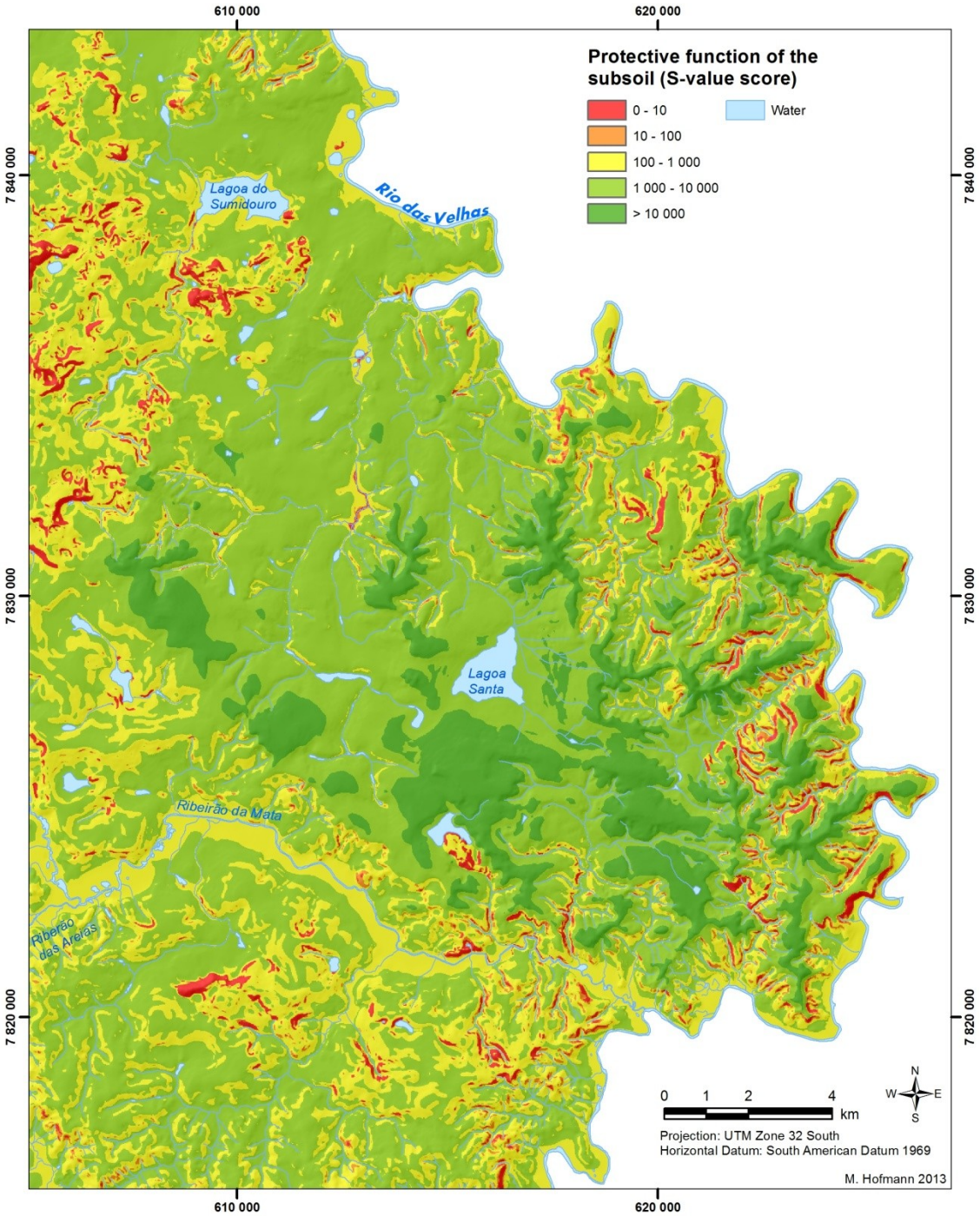
F. Groundwater vulnerability

1. Protective function of overlying layers



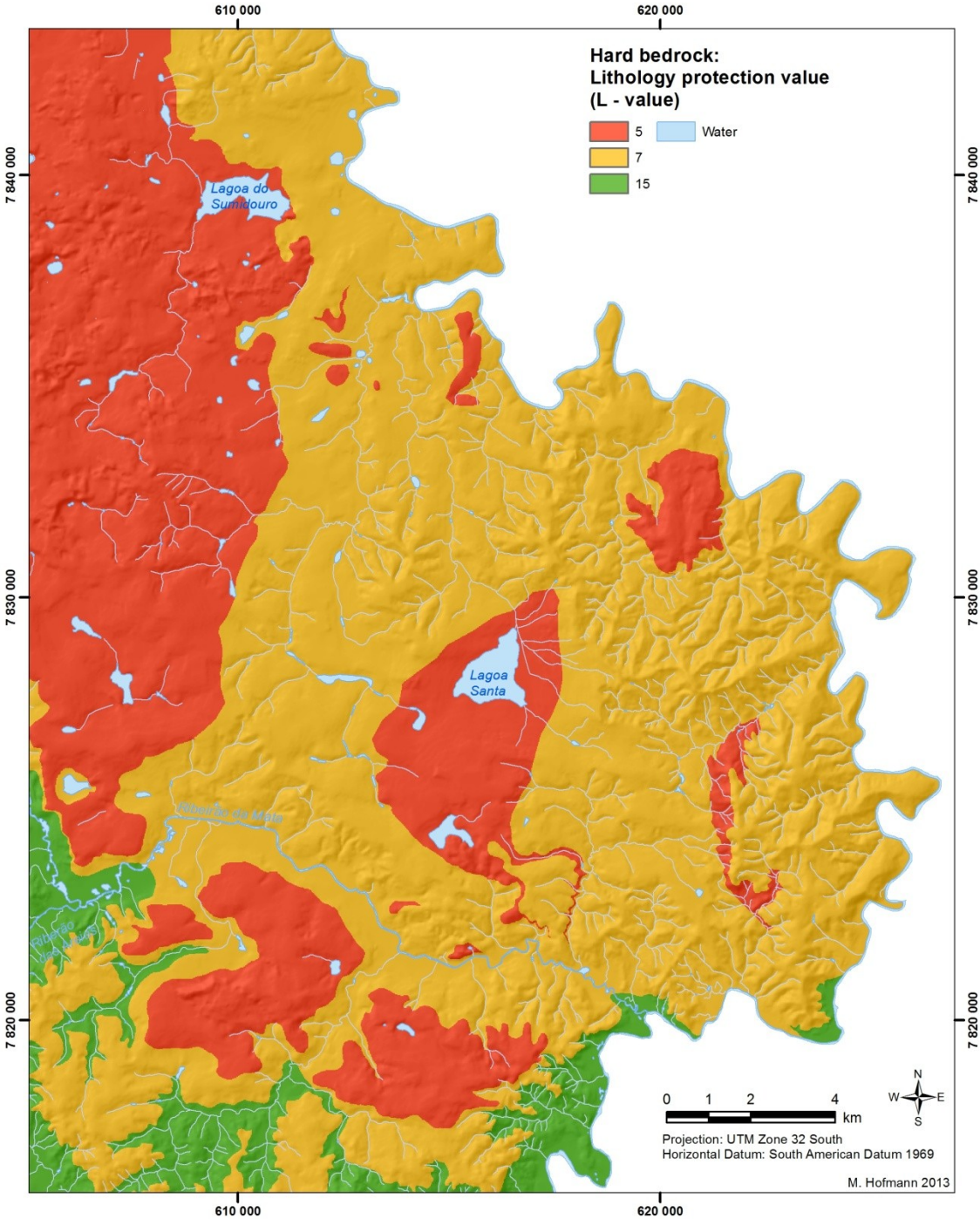
Map 69 Topsoil protection value for groundwater.

It refers to the first meter from surface, independent of soil horizons. The method is described in section 13.2.2.



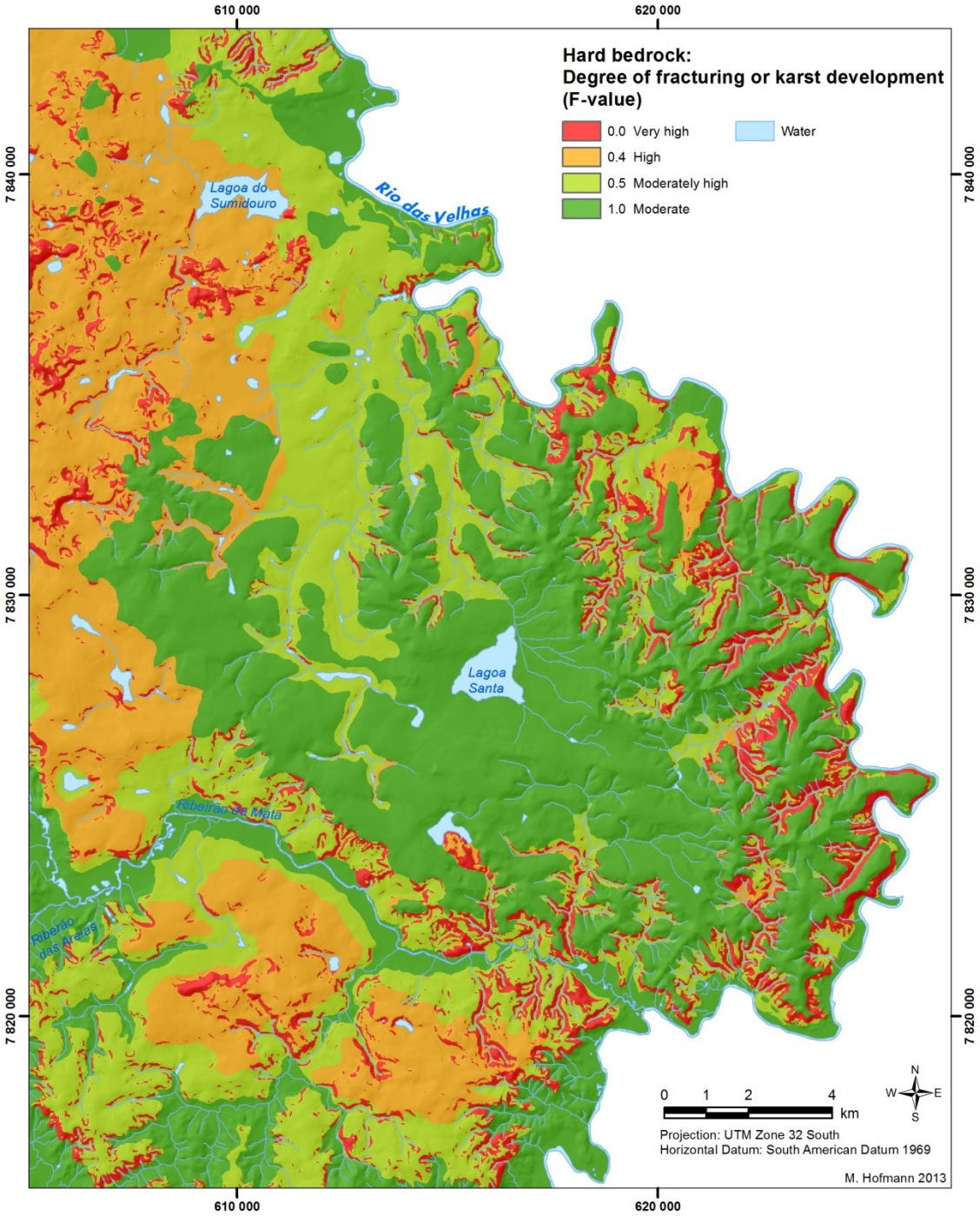
Map 70 Subsoil protection value for groundwater.

It refers to all soft material above groundwater below 1 meter from surface. The method is described in section 13.2.3.



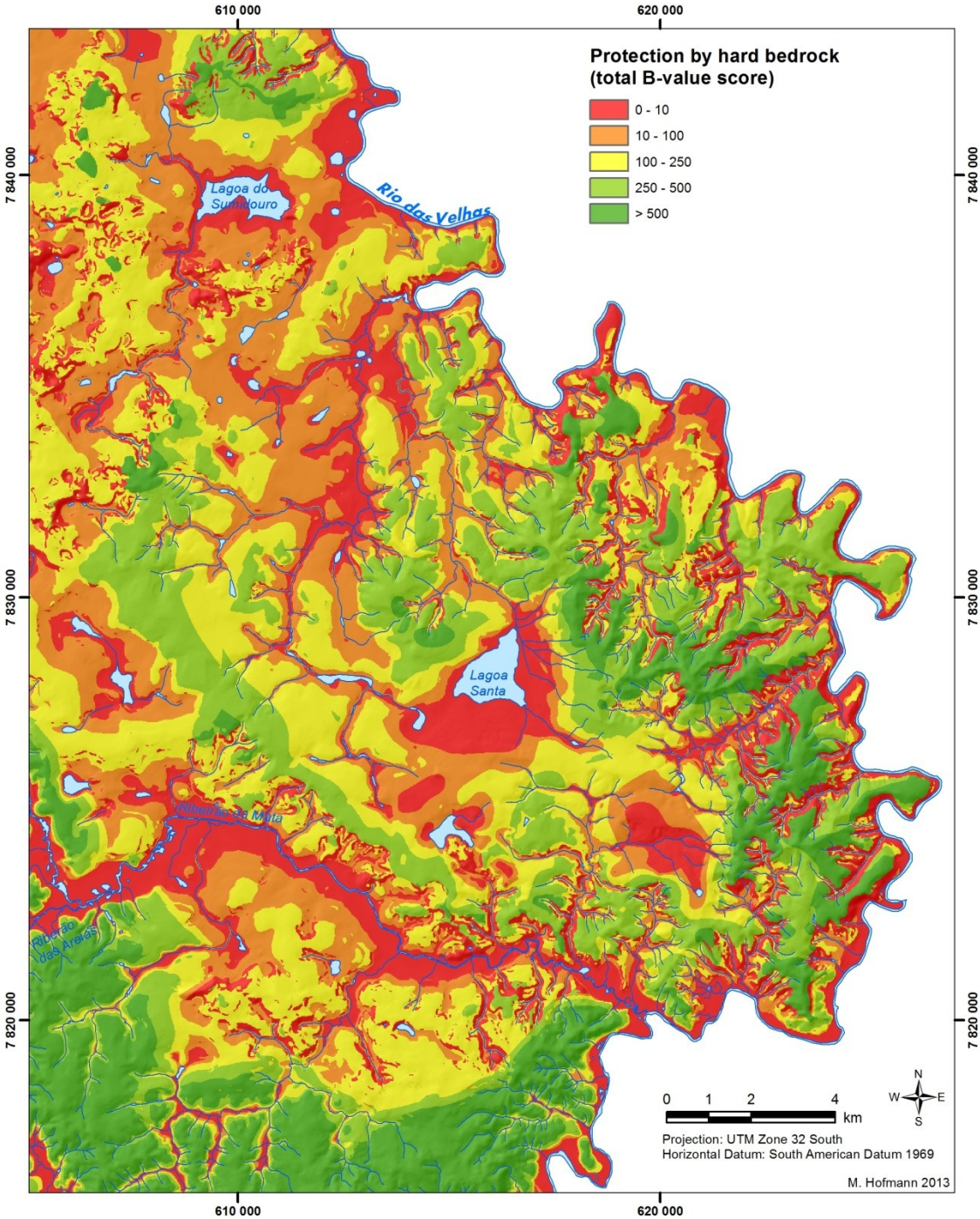
Map 71 Map of the lithology protection factor (L-value)

This factor relates to protection by hard bedrock (Sete Lagoas Formation and basement. See also section 13.2.4.



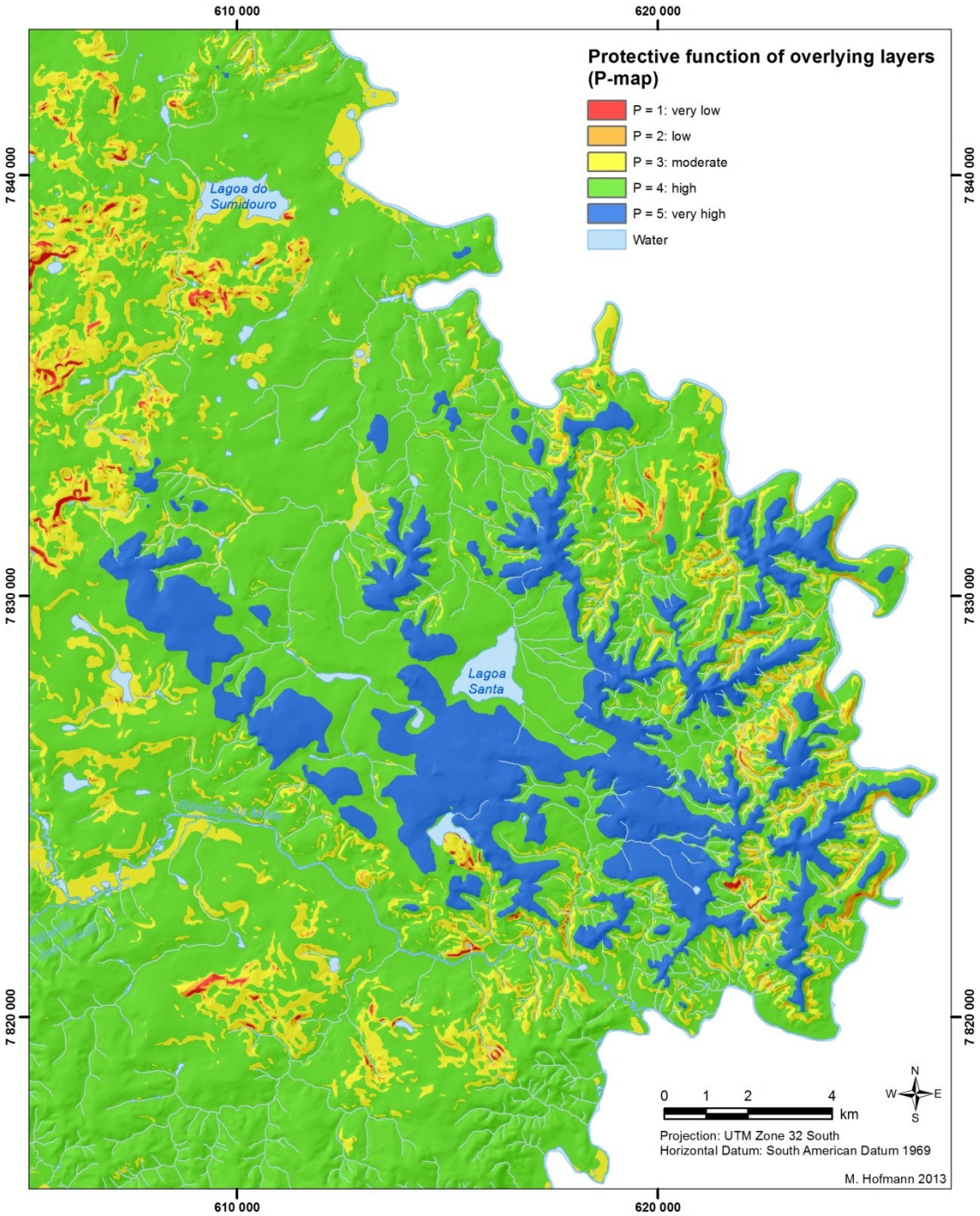
Map 72 Map of fracturing factor (F-value)

This factor modifies the protection of lithology (L-factor). See also section 13.2.4.



Map 73 Total bedrock protection

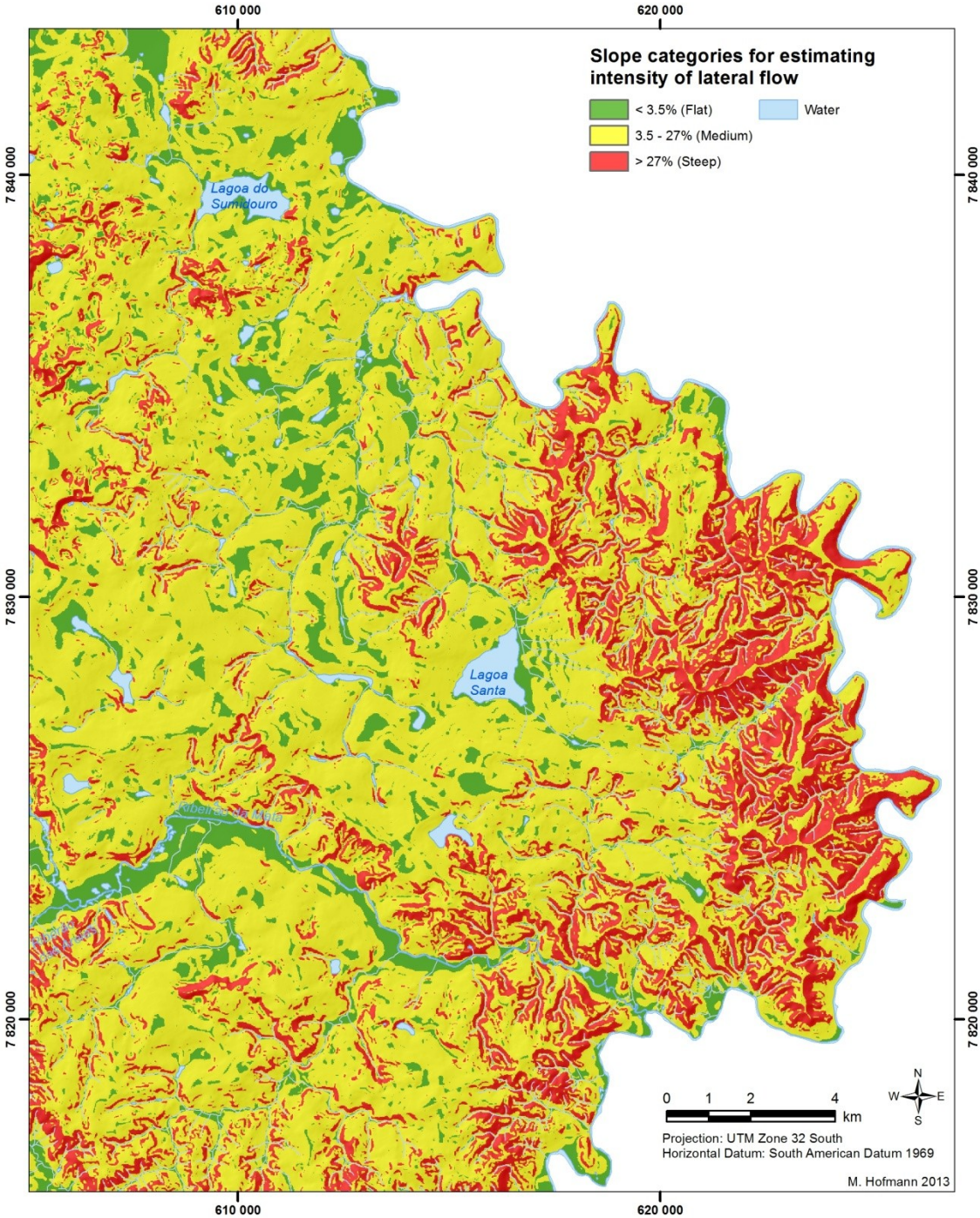
This factor is calculated as a multiplication of the L and F value with the thickness of the relevant bedrock strata. See also section 13.2.4.



Map 74 Protection of the groundwater by overlying layers (P-map).

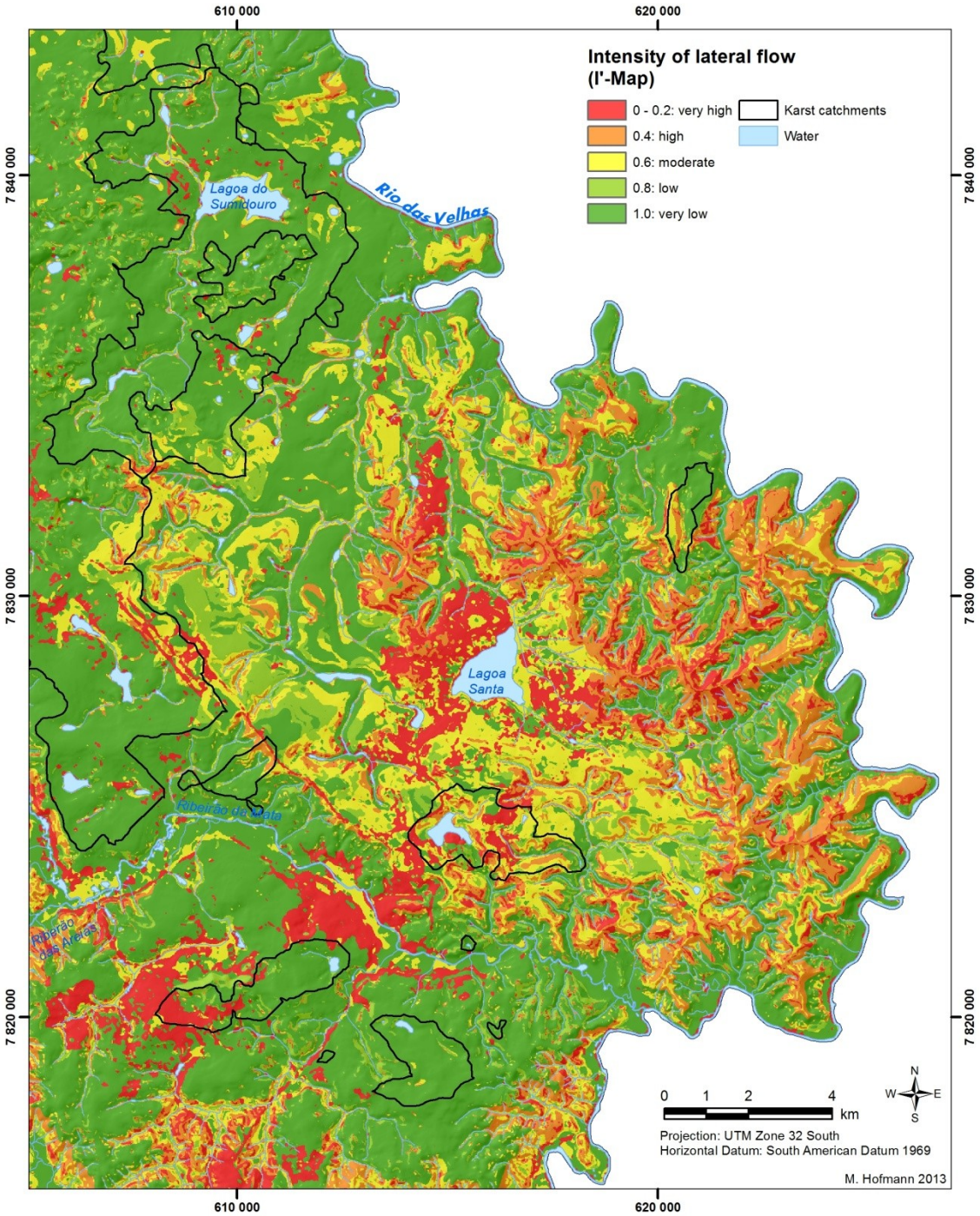
The method is described in section 13.3.

2. Degree of bypassing protective layers



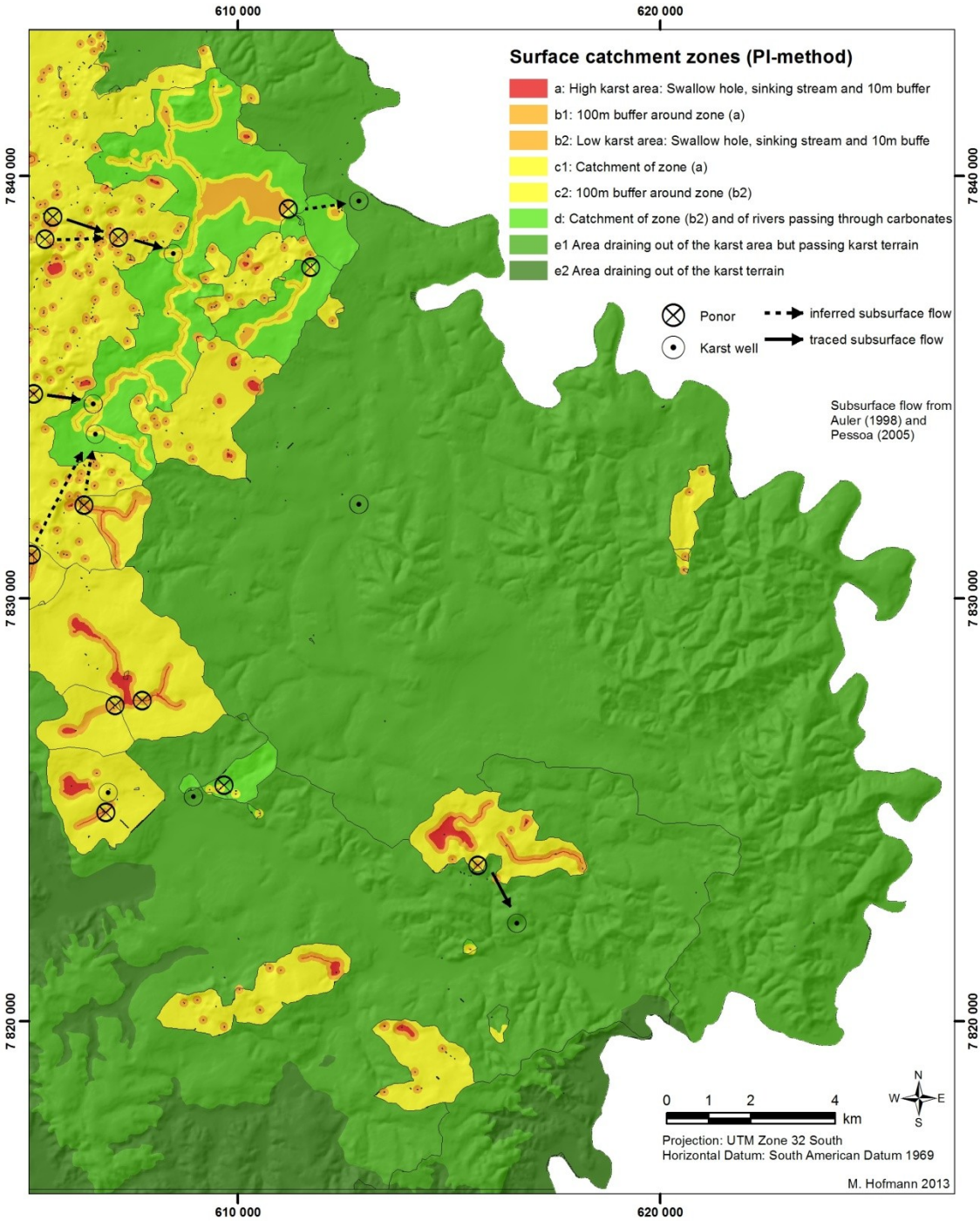
Map 75 Slope categories for the estimation of the degree of lateral flow.

See also section 13.4.



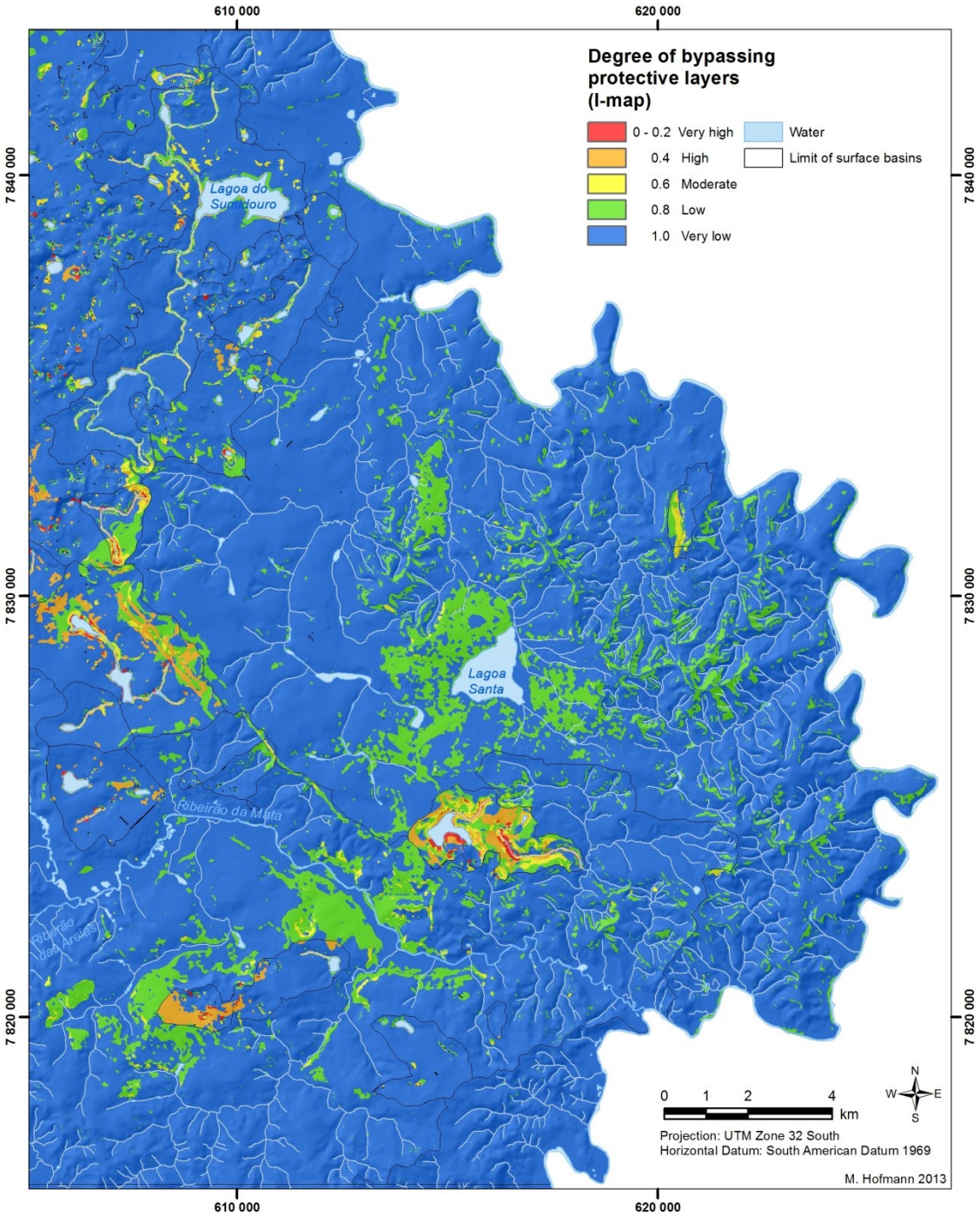
Map 76 I'-map showing the degree of lateral flow

The map is based on hydrological soil type, land use and slope categories. See also section 13.4.



Map 77 Surface catchment zones for groundwater protection.

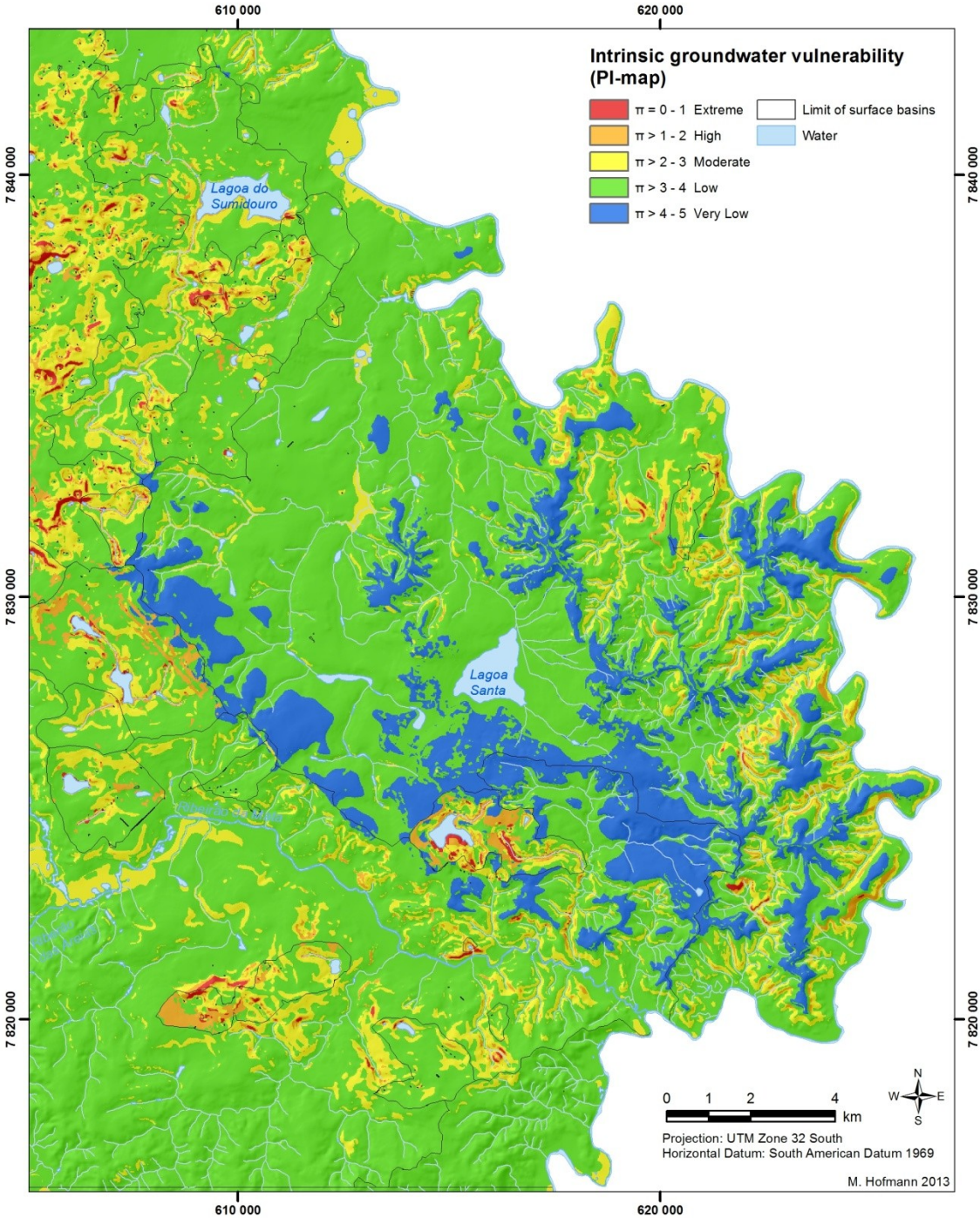
See also section 13.5.



Map 78 I-map showing the degree of bypassing protective layers.

The method is described in section 13.5.

3. Intrinsic vulnerability

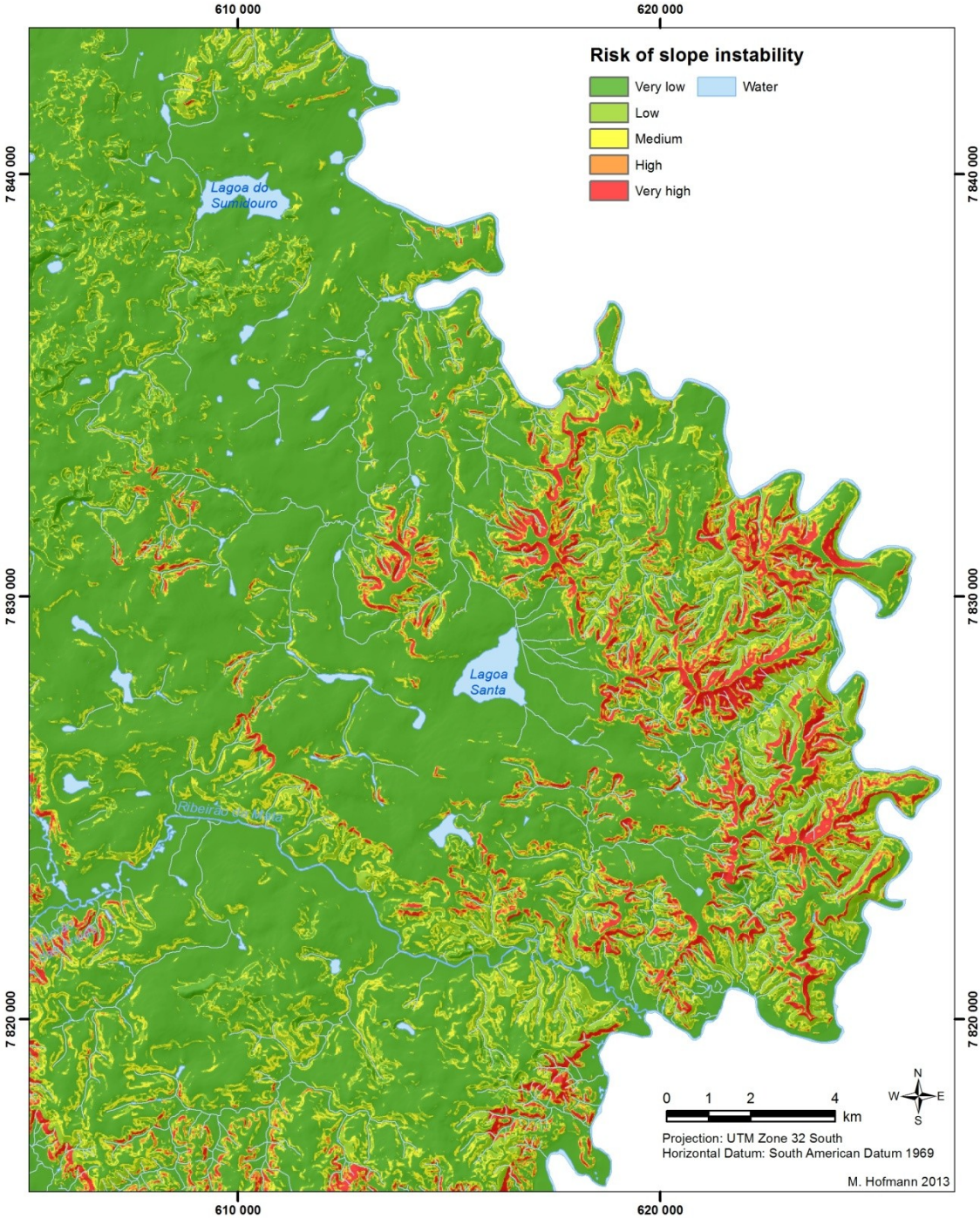


Map 79 PI-map showing the intrinsic vulnerability of the groundwater.

The map is based on protection of overlying layers (P-map) and degree of bypassing (I-map). See also section 13.6.

G. Hazards

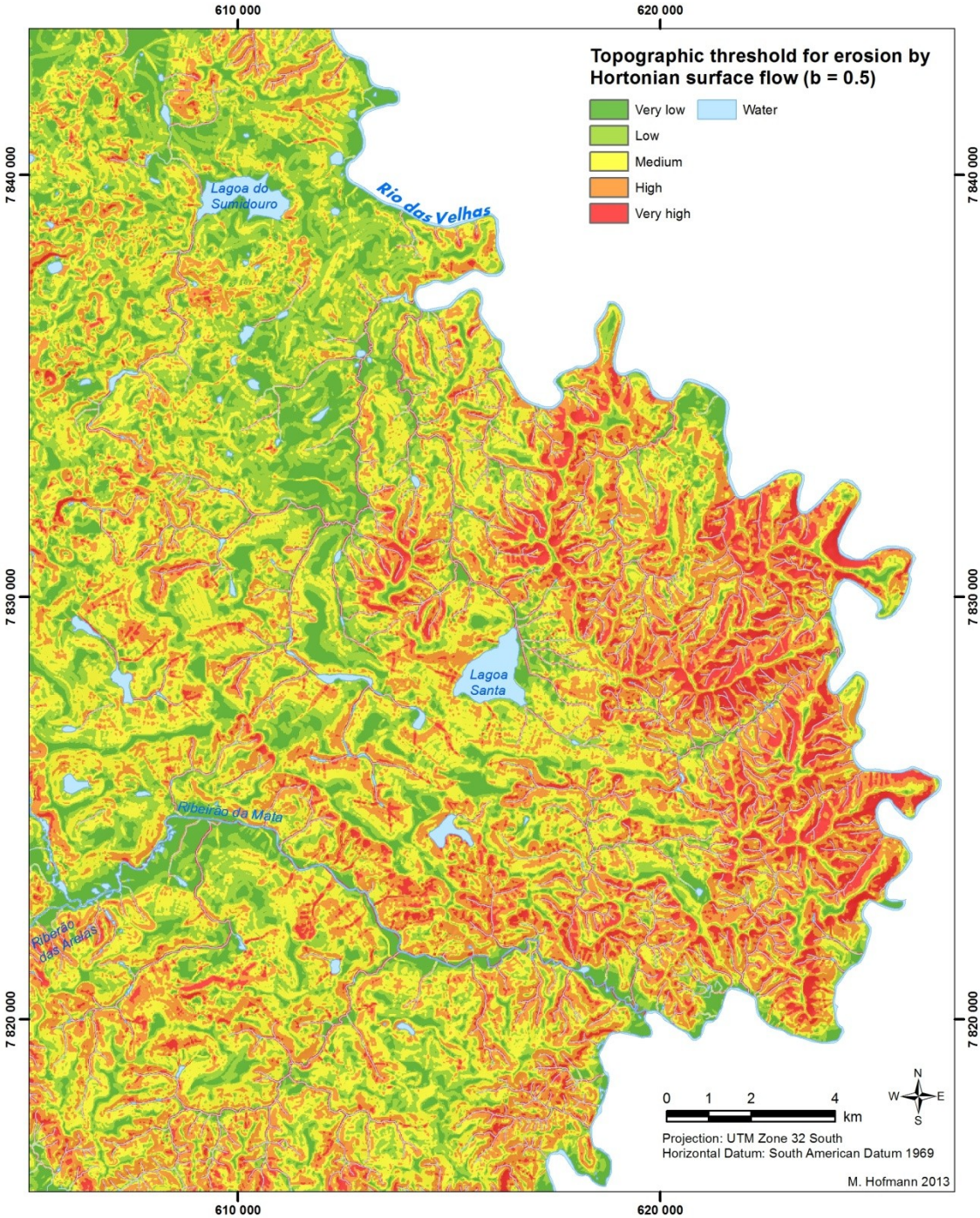
1. Risk of slope instability



Map 80 Risk of slope instability.

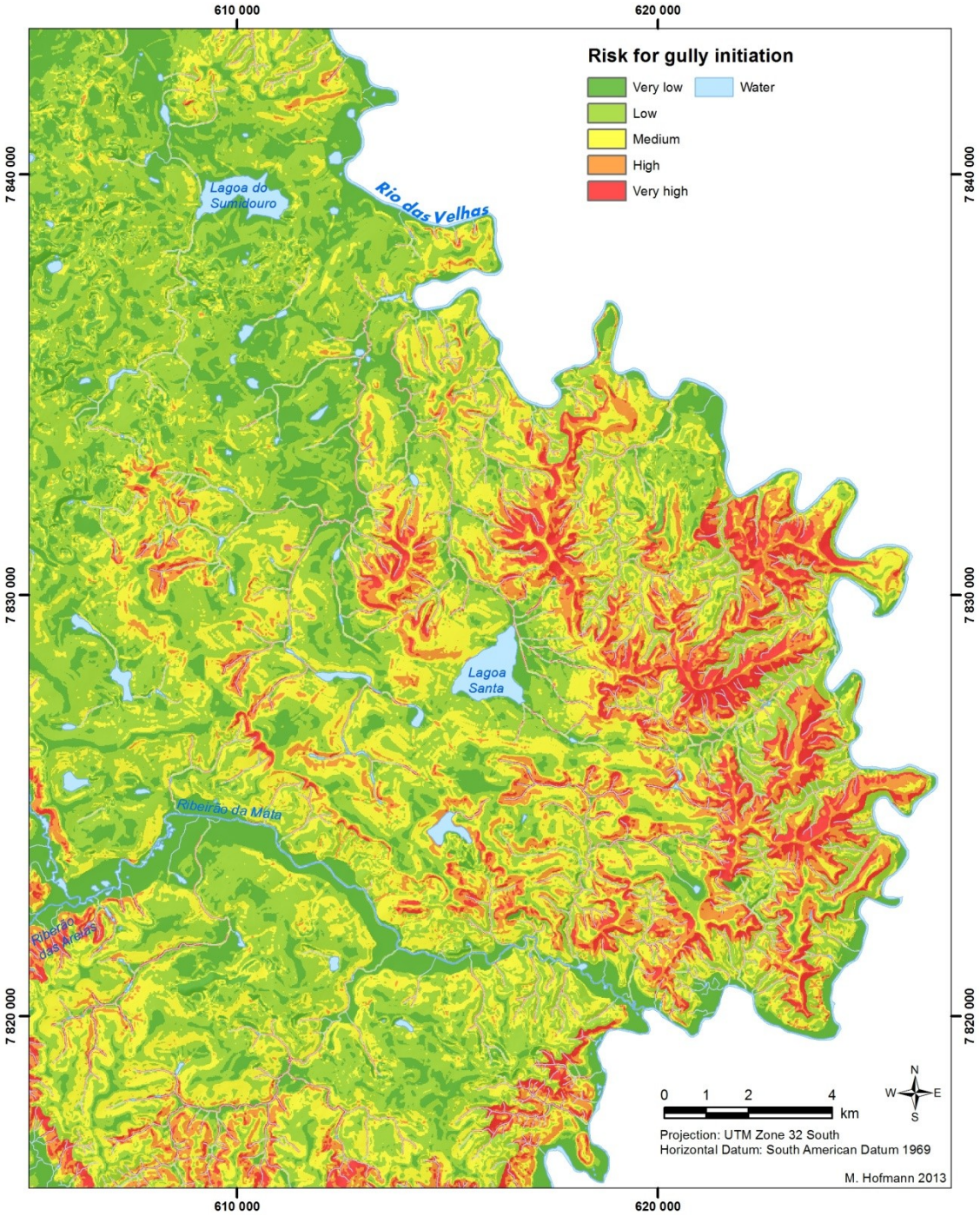
See also section 14.4.

2. Risk of gully initiation



Map 81 Topographic threshold for gully initiation.

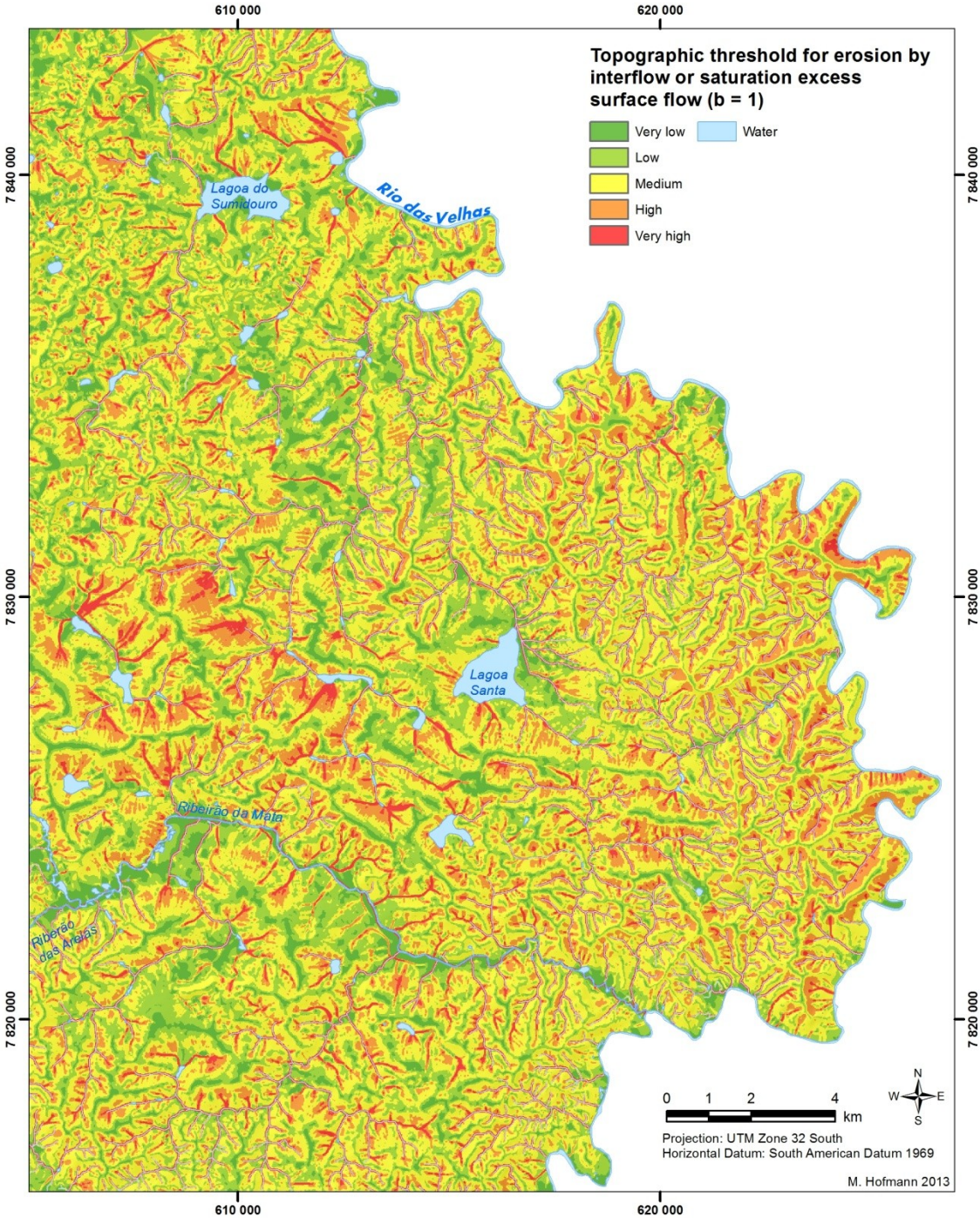
See also section 14.4.



Map 82 Map of gully initiation hazard by rills or small landslides.

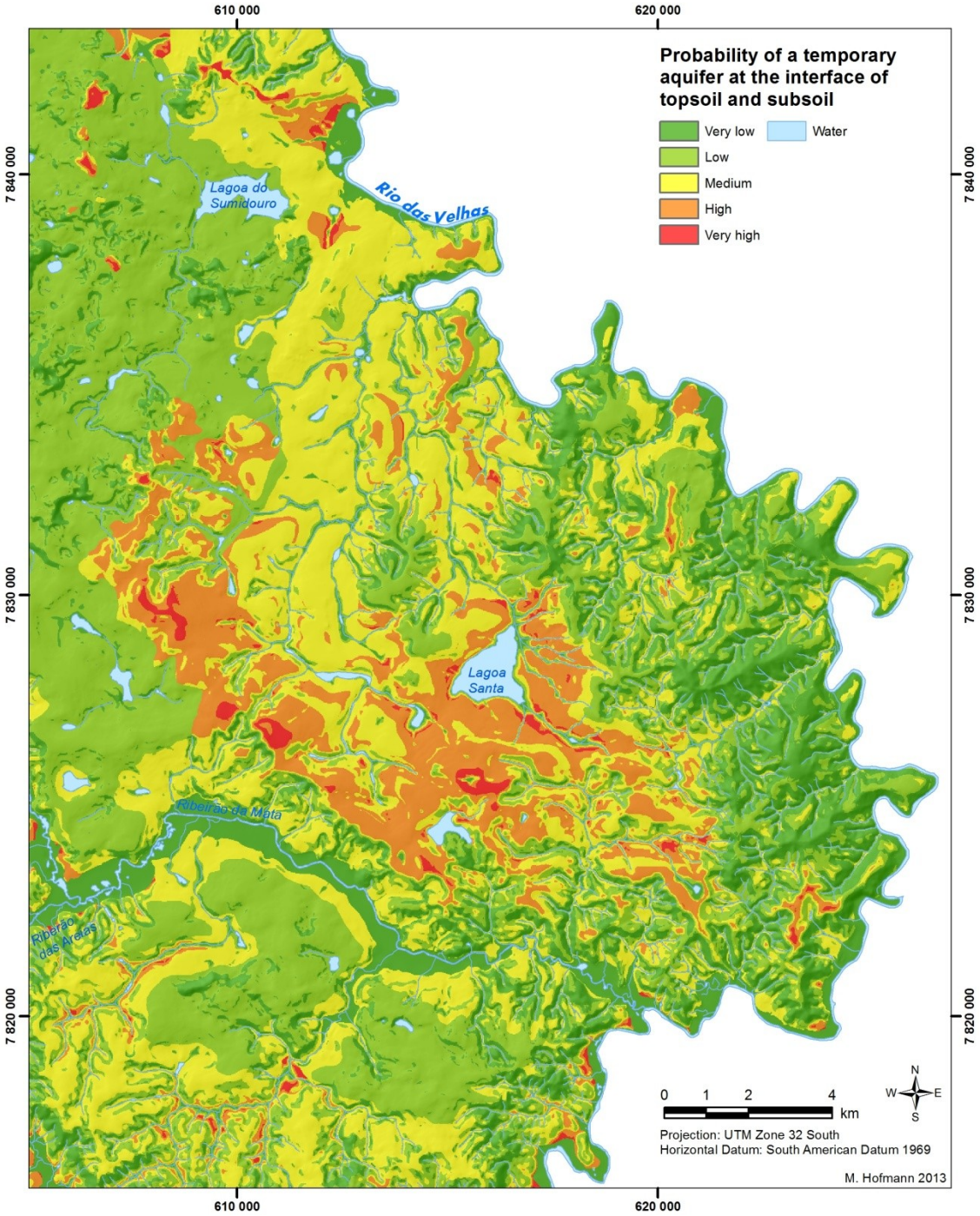
See also section 14.4.

3. Risk of gully propagation



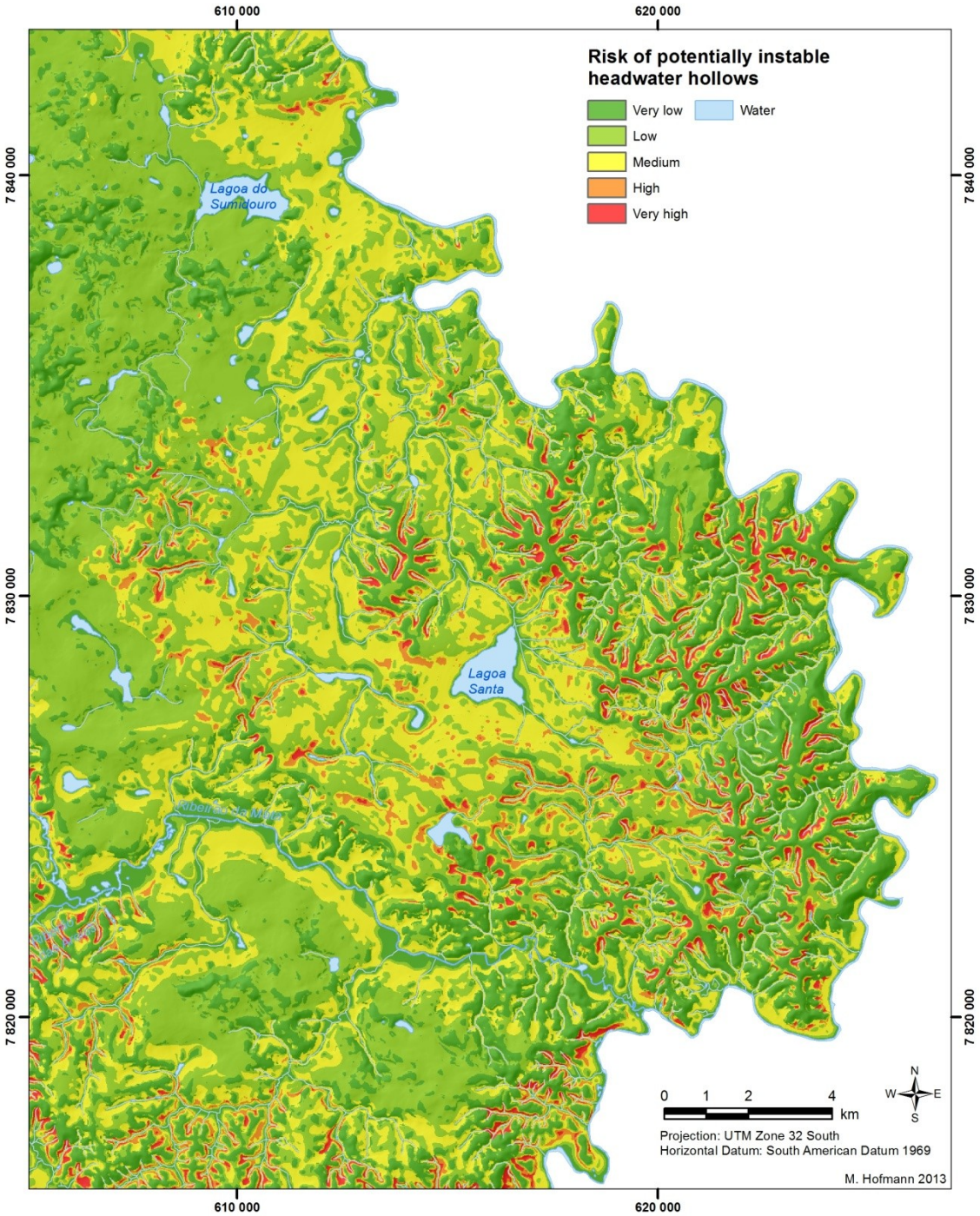
Map 83 Topographic threshold for gully propagation.

See also section 14.5.



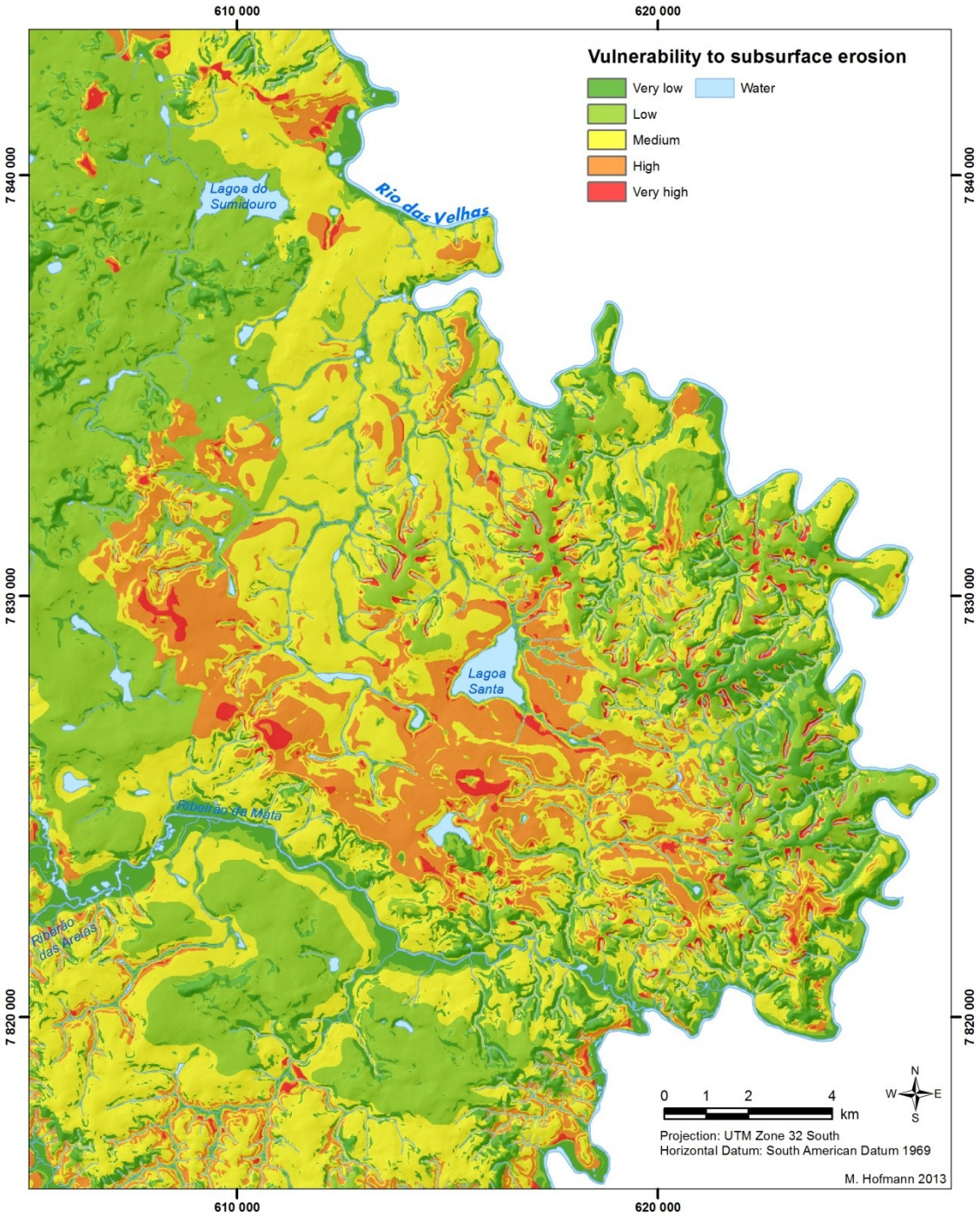
Map 84 Existence of a temporary aquifer at topsoil-subsoil interface.

See also section 14.5.



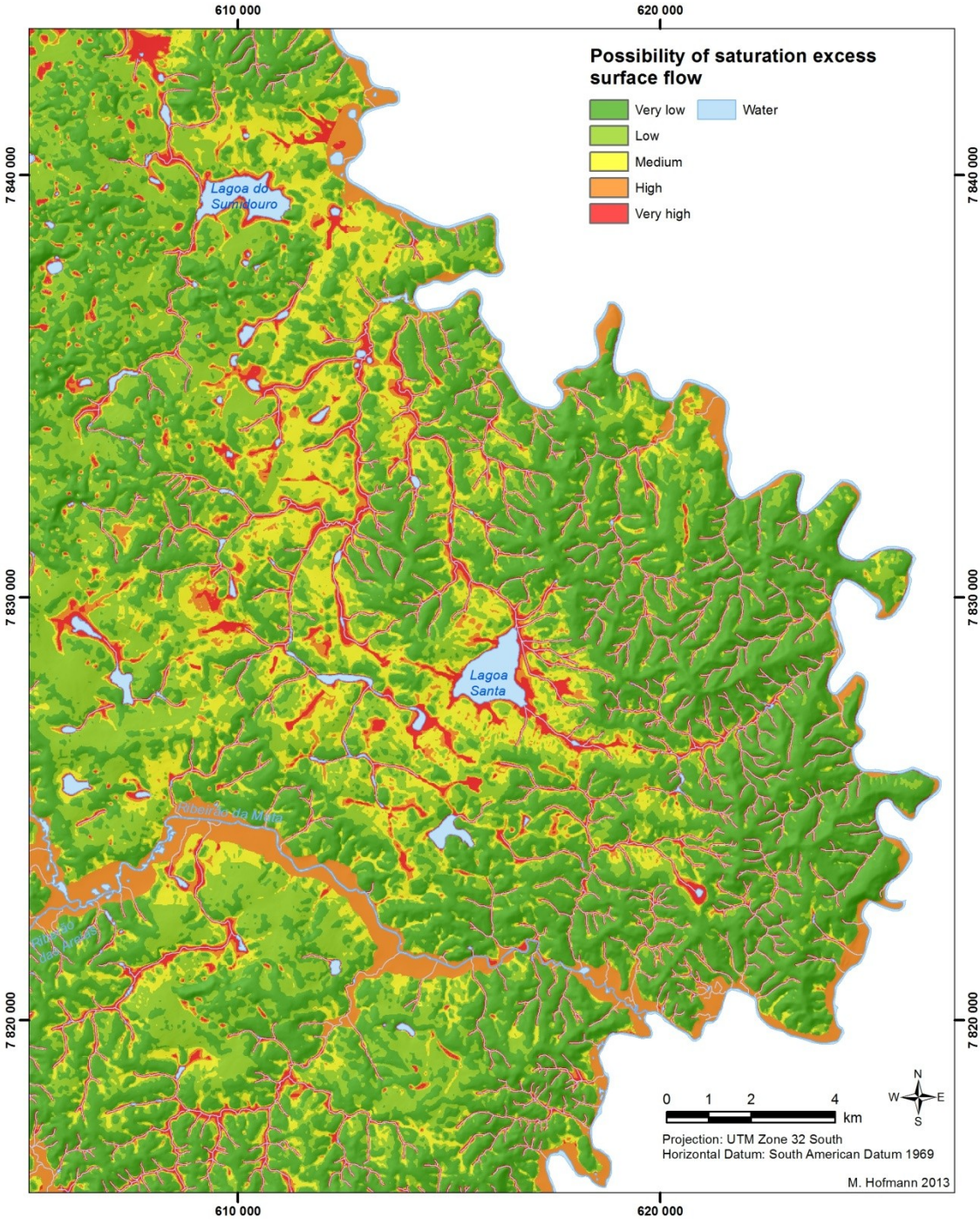
Map 85 Existence of potentially instable headwater hollows.

See also section 14.5.



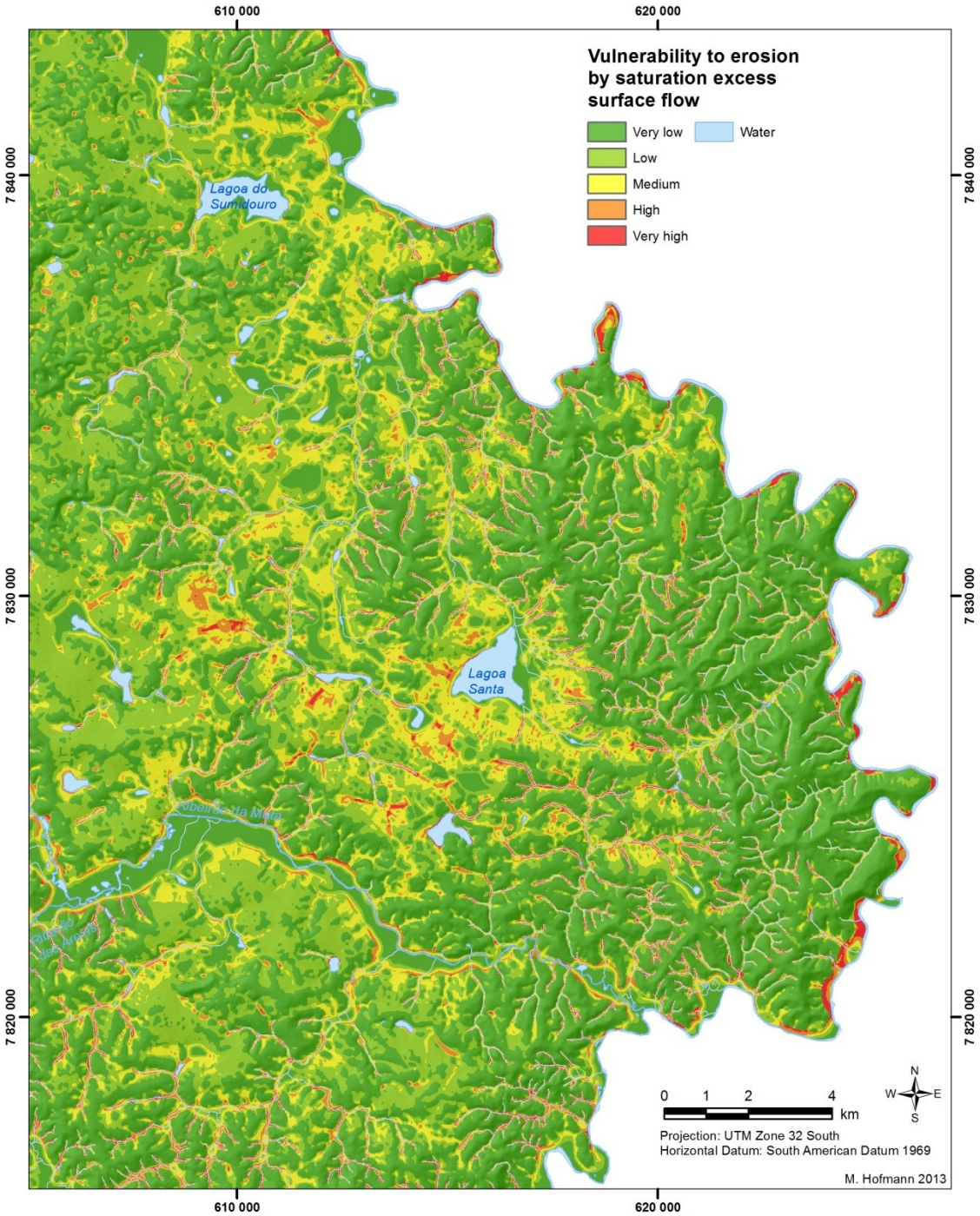
Map 86 Areas vulnerable to erosion by subsurface flow.

See also section 14.5.



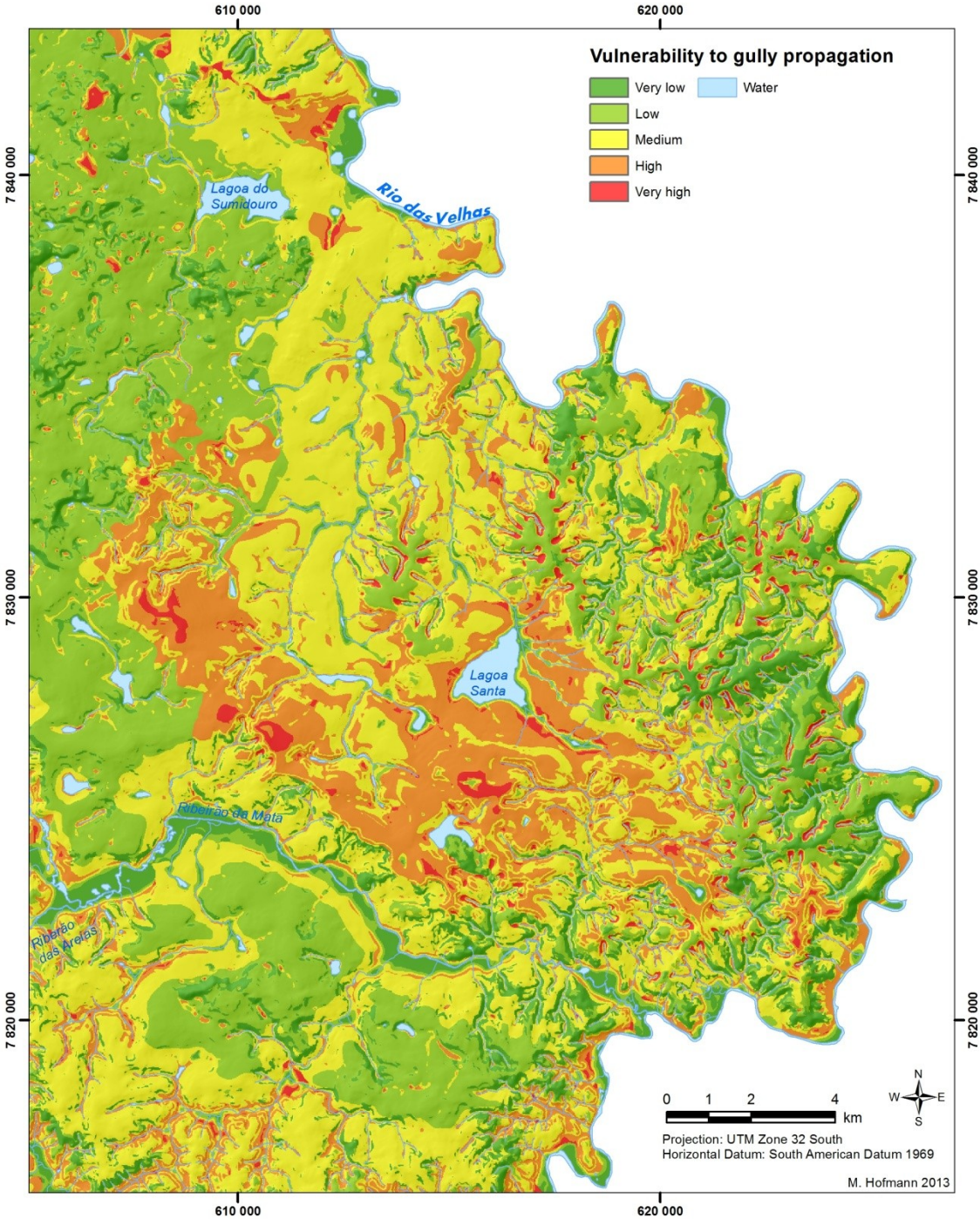
Map 87 Areas with possible saturation excess surface flow.

See also section 14.5.



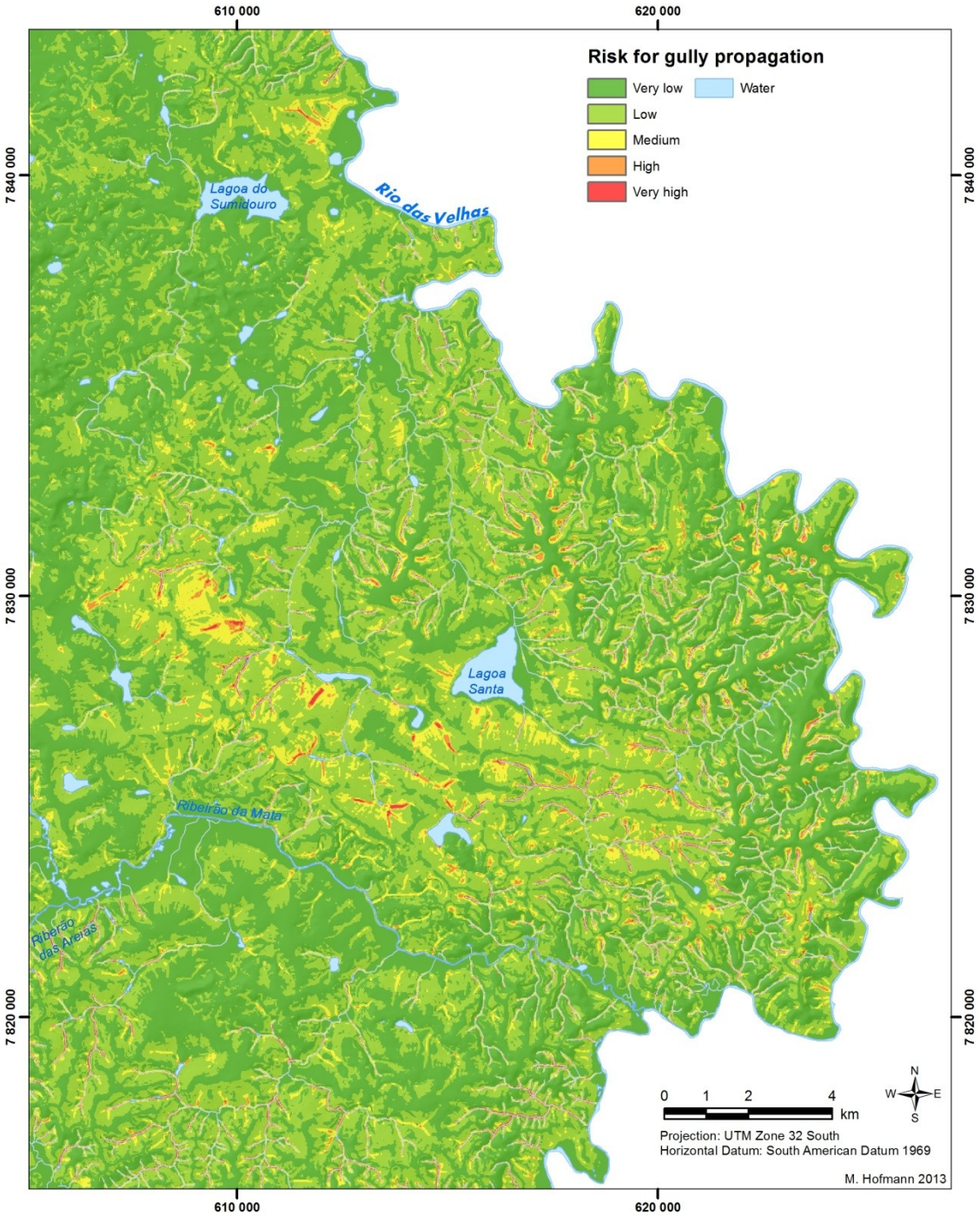
Map 88 Vulnerability to erosion by saturation excess surface flow.

See also section 14.5.



Map 89 Vulnerability to gully propagation.

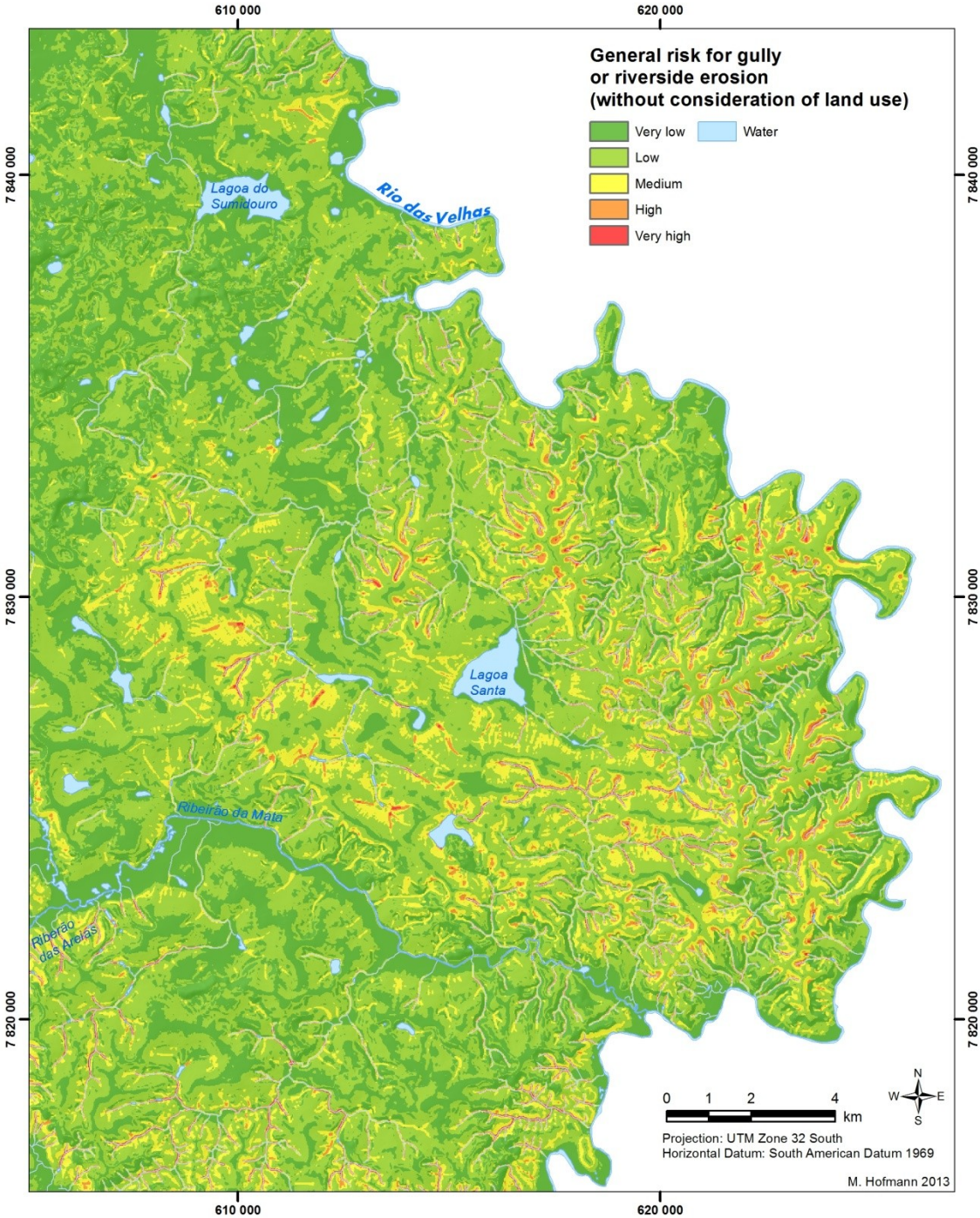
See also section 14.5.



Map 90 Risk of gully propagation.

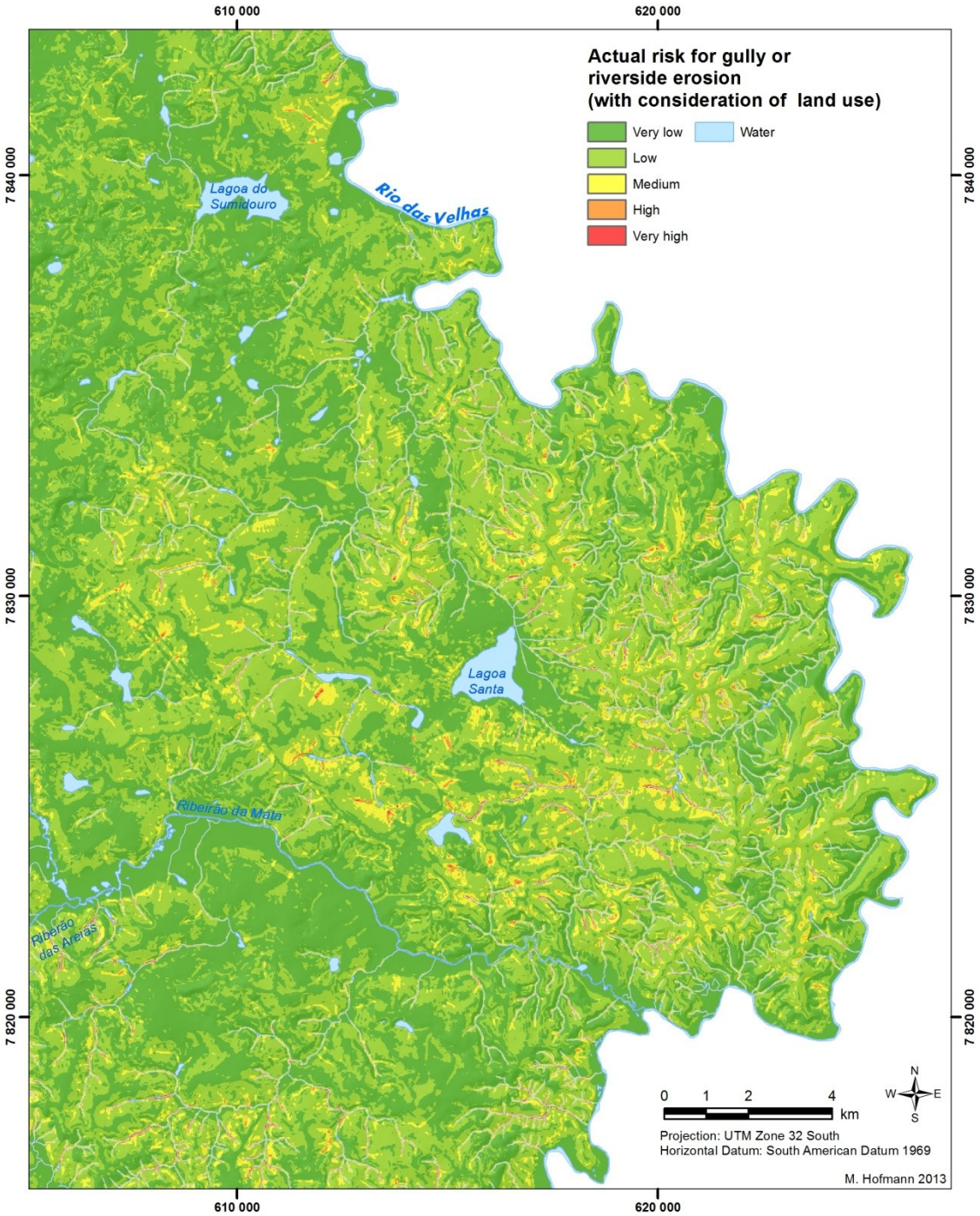
See also section 14.5.

4. Risk of gully erosion



Map 91 Risk of general gully or riverside erosion hazard.

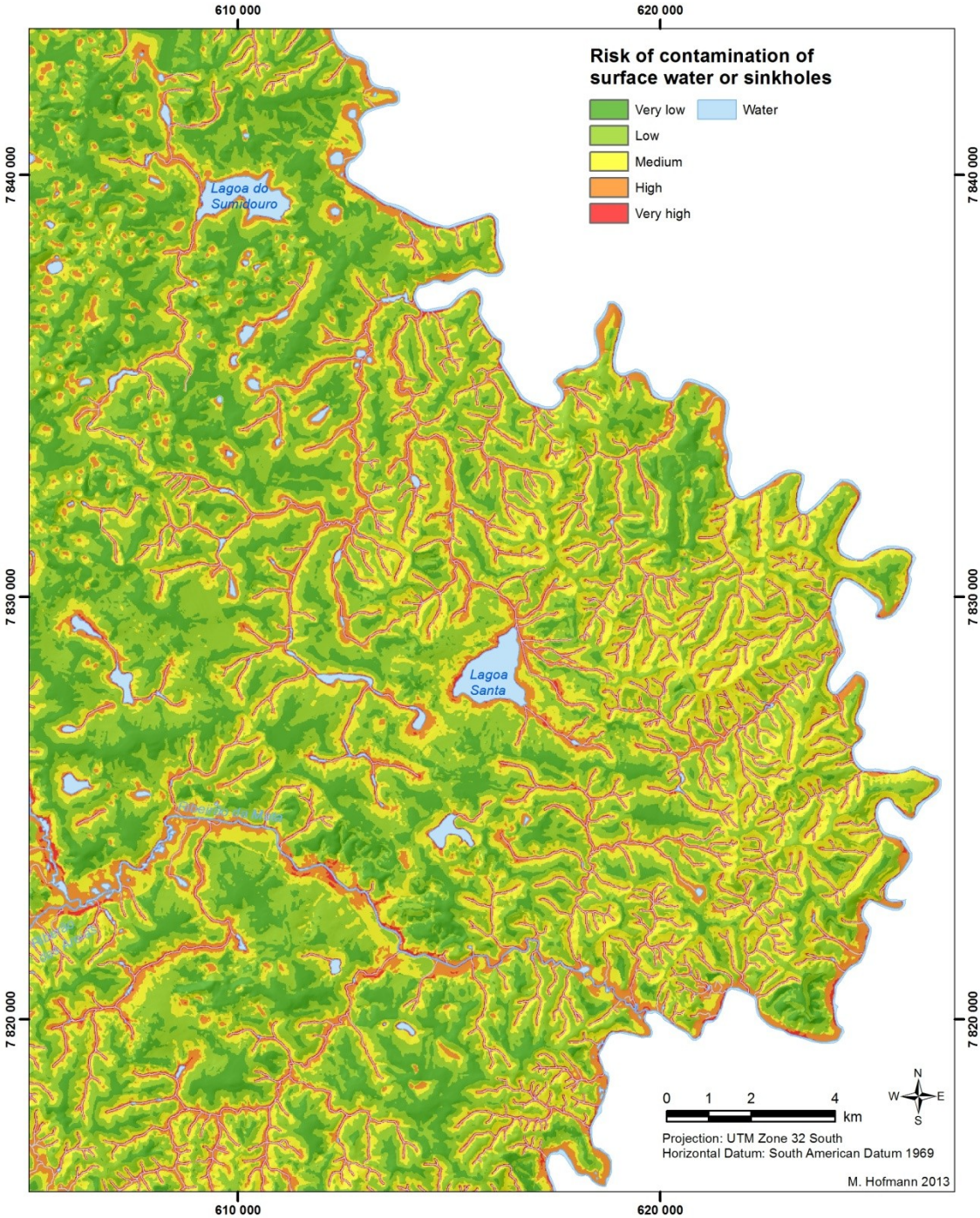
See also section 14.6.



Map 92 Risk of actual gully or riverside erosion hazard including land use.

See also section 14.6.

5. Risk of contamination of surface water



Map 93 Risk for contamination of surface water or sinkholes.

See also section 14.7.