Table 1. Description of elements and properties used for recognition and delineation of distinctive textural zones on satellite imagery. (Vedovello 1993, 2000).

Textural entities and properties	Description
Image texture element	The smallest continuous and uniform surface liable to be distinguishable in terms of shape and dimensions, and likely to be repetitive throughout an image. Usual types of image texture elements taken for analysis include: segments of drainage or relief (e.g. crestlines, slope breaks) and grey tones.
Texture density	The quantity of textural elements occurring within an area on image. Texture density is defined as the inverse of the mean distance between texture elements. Although it reflects a quantitative property, textural density is frequently described in qualitative and relative terms such as high, moderate, low etc. Size of texture elements combined with texture density determine features such as coarseness and roughness.
Textural arrangement	The form (ordered or not) by which textural elements occur and are spatially distributed on image. Texture elements of similar characteristics may be contiguous thus defining alignments or linear features on image. The spatial distribution may be repetitive and it is usually expressed by 'patterns' that tend to be recurrent (regularity). For example, forms defined by texture elements due to drainage expressed in rectangular, dendritic, or radial patterns.
Structuring **(Degree of spatial organisation)**	The greater or lesser organisation underlying the spatial distribution of textural elements and defined by repetition of texture elements within a certain rule of placement. Such organisation is usually expressed in terms of regular or systematic spatial relations, such as length, angularity, asymmetry, and especially prevailing orientations (*tropy* or directionality). *Tropy* reflects the anisotropic (existence of one, two, or three preferred directions), or the isotropic (multi-directional or no predominant direction) character of textural features. Asymmetry refers to length and angularity of linear features (rows of contiguous texture elements) in relation to an axe or main feature identified on image. The degree of organisation can also be expressed by qualitative terms such as high, moderate, low, or yet as well- or poorly-defined.
Structuring order	Complexity in the organisation of textural elements, mainly reflecting superposition of image structuring. For example, a regional directional trend of textural elements that can be extremely pervasive, distinctive and superimposed to other orientations also observed on imagery. Another example is given by drainage networks displaying different orders with reference to main stream lines and tributaries (1^{st}, 2^{nd}, 3^{rd} orders)

Table 2. Examples of codification of basic physiographic units (UBCs).

UBC	Code Description
BAA1	Physiographic domain: B (Sedimentary Basin)
	Bedrock lithology: A (Sandstone: medium to coarse grained, predominantly massif, quatzose)
	System of relief/landforms: A (Wide undulating hills, convex to flat top, gentle to moderate slope)
	Specific characteristics: 1 (sandy-clayey soil grading to sandy-silty in depth, thickness 1 to 5 m, predominant uni-directional arrangement of drainage and relief lines)
CLT1	Physiographic domain: C (Crystalline Basement)
	Bedrock lithology: L (Laminated Gneiss)
	System of relief/landforms: T (small rolling hills, sharp and narrow top, aligned crestlines, moderate slope)
	Specific characteristics: 1 (sandy to sandy-silty soils, thickness > 4 m, concave hillside)

Table 3. Relationships between 2nd (bedrock lithology) and 3rd (relief/landform systems) levels of physiographic compartmentalisation and image texture characteristics, particularly density and spatial organisation of texture elements associated with drainage and relief features.

Bedrock Lithology (assigned code)	**Image Texture Characteristics**
Granites **(S)** and granitic-gneisses **(R)**	Drainage and relief alignments that reflect structural geological lineaments at NW and N-S orientation. High-density (texture density related to) drainage forms (> 3 km/km^2) with directional anisotropy expressed by rectangular and oblique patterns.
Gneisses: banded **(B, O)**, laminated **(L)**, schistose **(N)**	Moderate to high-density (2-3 km/km^2) drainage forms: sub-dendritic, parallel, sub-parallel to angulated, tendency to bi-or tri-directional anisotropy (one direction mostly associated with metamorphic foliation).
Sandstone: medium to coarse grained **(A)**	Dendritic drainage forms, locally radial or angulated, low to moderate density (< 2 km/km^2), and variable tropy (uni-bi, and tri-directional to isotropic).
Mudstones **(B)**, siltstones **(G)**, rythmites **(B, G)** and fine-grained sandstones **(C, F)**	Moderate to high (2-3 km/km^2) density of drainage lineaments with sub-dendritic to angulated forms, bi- or tri-directional anisotropic arrangements that grade into isotropic (sandy constituency).
Dolerites (intrusive volcanic rocks) **(D)**	Lineaments associated with positive relief slope breaks of greater amplitude. Drainage forms tend to be isotropic and low to moderate (< 2 km/km^2) density of drainage lines.
Aluvional deposits (no code)	Smoother texture bounded by negative slope breaks in association with dense vegetation strips.
Relief/landform system (assigned code)	
Wide undulating hills **(A)**	Convex hillsides and flat tops characterised by relative scarcity of textural elements related to drainage. Subtle positive slope breaks. Gentle slopes.
Small undulating hills **(P, M)**	Predominant concave hillsides and valleys identified by negative slope breaks, sharp and narrow ridges, aligned crestlines in some cases, gentle to moderate slope.
Large rolling hills **(R)**	Variable and alternate concave and convex hillsides, mostly associated with positive slope breaks, sharp but wide ridges, aligned crestlines, steep slope.
Small rolling hills **(T, C)**	Predominant concave hillsides and valleys identified by negative slope breaks, sharp and narrow ridges, aligned crestlines transverse to the main ridge top in some cases, moderate slopes.

Table 4. Cenozoic tectonic evolution of the region of Campinas according to Fernandes & Amaral (2002).

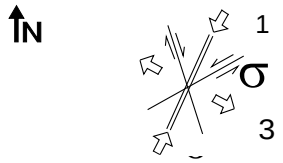
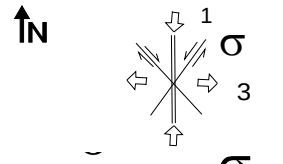
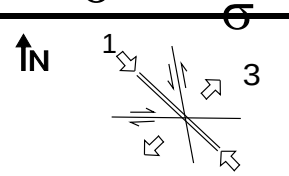
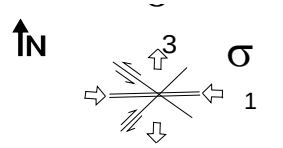
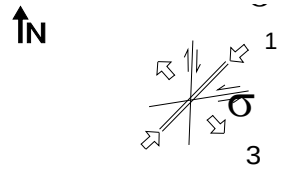
Age	Principal palaeostress directions (plan view)	Shear fracture orientations	Extensional fracture orientations	Tectonic Event
Quaternary		N20-30W and N50-60E	N10-30E	E5-NNE
		N30-50W and N30-50E	NS	E4-NS
		WNW and NNW-NS	N30-60W	E3-NW
Neogene		N45-65W and N45-65E	EW	E2-EW
Cretaceous to Paleogene		EW-ENE and NNE-NS	NE	E1-NE

Table 5. Qualitative scores attributed to the parameters (density of lineaments, density of lineament intersections, predominant tectonic event) taken for derivation of classes of fracturing.

Parameter	Density of lineaments (km/km^2)		Density of lineament intersections (km/km^2)		Predominant tectonic event		
Parameter value	> 3,90*	< 3,90*	> 2,99**	< 2,99**	E3-NW	E4-NS	Undefined
Score	A	B	A	B	A	B	B

* Range of average values of density of fracturing for UBCs in Test Areas T1 and T2: from 1.26 and 7.97 km/km^2.

** Range of average values of density of lineament intersections for UBCs in Test Areas T1 and T2: from 0.06 to 10.97 intersections per km^2.

Table 6A. Summary data for Test Area T1. 1) BCU: basic compartmentalisation unit code; 2) G_LITO: grouped bedrock lithology; 3) CLAS_FRAT: class of fracturing; 4) TYPE_SOIL: predominant soil type; 5) THICK_SOIL: average soil thickness; 6) NA: average water table depth; 7) CLAS_DECLIV: class of slope steepness.

UBC	GROUP_ LITO	CLAS_FRAT	TYPE_SOIL	THICK_SOIL	N_A	CLAS_DECLIV
CSA1	Gr	2	sandy	> 6,5 m	<10, >10	low
CLC1	X	3	No information	No information	>10 ~ <10	medium
CRA1	Gr	3	sandy	> 6,5 m	>10 ~ <10	medium
CNC2	X, Bx	3	sandy to sandy-silty	> 4,0 m	<10, >10	medium
CRR3	Bx/GnGr	3	sandy grading to clayey in depth	> 3,5 m	>10 ~ <10	very high
CNC1	B, X	3	clayey to sandy in depth	> 1,0 m	>10 ~ <10	medium
BAC1	IAM, Gr/X	1	sandy	No information	<10, >10	medium
CRR2	GnGr/B	3	No information	No information	>10 ~ <10	very high
CRR5	GnGr/B, Bx	3	sandy-clayey grading to clayey-sandy or sandy-silty in depth; occurrence of detached blocks	5 - 10 m	>10, <10	high
COC3	Bx, B	3	sandy	3,5 m	>10, <10	medium / high
CSR3	Gr, Bx	3	occurrence of detached blocks	1 - 5 m	<10, >10	high
CLR3	X, Bx/GnGr	3	No information	No information	<10, >10	high
CLT1	B, X, Bx/GnGr	3	sandy to sandy-silty	4,0 m	<10, >10	medium

Table 6B. Summary data for Test Area T2. 1) BCU: basic compartmentalisation unit code; 2) G_LITO: grouped bedrock lithology; 3) CLAS_FRAT: class of fracturing; 4) TYPE_SOIL: predominant soil type; 5) THICK_SOIL: average soil thickness; 6) NA: average water table depth; 7) CLAS_DECLIV: class of slope steepness.

UBC	GROUP_ LITO	CLAS_FRAT	TYPE_SOIL	THICK_SOIL	N_A	CLAS_DECLIV
BAA1	IAM, IAF	1	sandy-clayey grading sandy-siltyin depth	1 - 5 m	>10, <10	low/medium
BBP2	IDR, IAF, D	3	sandy-silty grading to sandy-clayey in depth; medium to low compacity	1 - 5 m	<10, >10	medium
BAA2	IAF, IAM	1	clayey-sandy	1 - 5 m	>10 ~ <10	medium
BAP1	IAM, D	2	sandy a sandy-silty grading to silty-sandy in depth	> 2 m	>10, <10	low/medium
BBM3	IDR, FRC, D	1	sandy-clayey; blocky; moderately compact	> 2 m	<10, >10	low
BCA1	IAF	1	clayey-sandy grading to sandy-silty in depth; blocky	> 1,8 m	<10 ~ >10	medium
BGA1 (1)	FRC	1	sandy-clayey grading to sandy-silty e clayey-sandy in depth	> 2 m	>10, <10	low
BBP7	IDR, IAF, D	3	sandy-clayey a sandy-silty	> 2 m	<10 ~ >10	low/medium
BCP2	FRC, D	2	sandy a sandy-silty; massif	5 - 10 m	>10	low
BFA1	FRC, IAF	1	sandy-clayey; friable ; granular	> 2 m	> 10, <10	low
BGA1 (2)	FRC, IAF	1	sandy-clayey grading to sandy-silty e clayey-sandy in depth	> 2 m	>10, <10	low
BDA2	D, IAF	2	clayey-sandy	No information	<10, >10	low
BDA1	D, IAF	1	clayey-sandy a clayey	No information	<10, >10	low

Table 7A. Attributes used for evaluation/classification of units (BCUs) according to their potential influence (high, moderate, low) on groundwater vulnerability to pollution hazards.

ATTRIBUTES	HIGH (A)	MODERATE (M)	LOW (B)
BEDROCK LITHOLOGY	- IAM, Gr/X* (coarse-grained sandstones + mix of granites and schists) - IAM (coarse-grained sandstones)	- Gr (granites) - GnGr /B, X, Bx* (mix of granitic and banded gneisses + laminated to schistose gneisses + banded mylonitic gneisses) - B, X, Bx/Gngr* (banded gneisses + schistose gneisses + mix of banded mylonitic gneisses and granitic-gneisses) - FRC (Rio Claro Formation – mix of sandy mudstones, siltstones, muddy sandstones and rythmites) - IAF (fine-grained sandstones)	- B (banded gneisses) - X (laminated to schistose gneisses) - Bx (banded mylonitic gneisses) - IDR (mudstones with pebbles and rythmites) - D (dolerites)
FRACTURING	3	2	1
SOIL TYPE	- Sandy - Sandy-silty - Sandy-clayey grading to sandy-silty - Sandy to sandy-silty - Clayey-sandy grading to sandy-silty	- Sandy-clayey - Sandy- silty to sandy-clayey - Sandy grading to clayey - Sandy-clayey grading to clayey - Clayey-sandy grading to sandy-clayey - Clayey grading to sandy	- Clayey - Clayey-sandy
SLOPE STEEPNESS	- Low	- Low to medium - Medium - Medium to high	- High - Very high

* Groups separated by forward slash comprise an undistinguished mixture of bedrock lithologies. The “comma” sign indicates the occurrence of more than one group of bedrock lithology listed in decreasing order according to their occurrence in terms of areal distribution.

Table 7B. Attributes used for evaluation/classification of units (BCUs) according to their potential influence (high, moderate, low) on susceptibility to land instability processes.

ATTRIBUTES	HIGH (A)	MODERATE (M)	LOW (B)
BEDROCK LITHOLOGY	- Iam, Gr/X* (coarse-grained sandstones + mix of granites and schists) - IAm (coarse-grained sandstones) - FRC (Rio Claro Formation – mix of sandy mudstones, siltstones, muddy sandstones and rythmites) - X (laminated to schistose gneisses) - Gr (Granites) - GnGr /B, X, Bx* (mix of granitic and banded gneisses + laminated to schistose gneisses + banded mylonitic gneisses) - B, X, Bx/Gngr* (banded gneisses + schistose gneisses + mix of banded mylonitic gneisses and granitic-gneisses)	- IAF (fine-grained sandstones) - B (banded gneisses) - Bx (banded mylonitic gneisses)	- IDR (mudstones with pebbles and rythmites) - D (dolerites)
FRACTURING	3	2	1
SOIL TYPE	- Sandy - Silty-sandy - Sandy-clayey grading to silty-sandy - Sandy to silty-sandy - Sandy-silty to sandy-clayey	- Sandy-clayey - Sandy grading to clayey - Clayey-sandy grading to sandy-silty - Clayey grading to sandy	- Clayey - Clayey-sandy - Clayey-sandy grading to sandy-clayey - Sandy-clayey grading to clayey
SLOPE STEEPNESS	- High - Very high - Medium to high	- Medium	- Low - Low to medium

* Groups separated by forward slash comprise an undistinguished mixture of bedrock lithologies. The “comma” sign indicates the occurrence of more than one group of bedrock lithology listed on decreasing order according to their occurrence in terms of areal distribution.

Table 7C. Possible combinations of scores “A” (high), “M” (moderate), and “B” (low) respective to the four attributes (bedrock lithology, fracturing, soil type, and slope steepness) used for evaluation/classification of units (BCUs) and evaluation classes resulting from these combinations.

Combinations of scores	Evaluation classes
AAAA	Very high
AAAM, AAAB, AAMM	High
AAMB, AABB, AMMM, AMMB, MMMM	Medium
AMBB, ABBB, MMMB, MMBB, MBBB, BBBB	Low

Table 8. Partial susceptibility associated with each individual attributes and overall susceptibility to land instability processes resulting from the summation of all influential factors (attributes). A = high, M = medium and B = low.

Test Area	UBC	Attributes liable to influence susceptibility				Susceptibility Class
		Lithology	Fracturing	Soil type	Declivity	
T3	CSA1	A	M	A	B	High
	CLC1	A	A	M *	M	High
	CSA2	A	A	A	M	High
	CNC2	A	A	A	M	High
	CRR3	A	M	M	A	High
	CNC1	M	A	M	M	Moderate
	BAC1	A	B	A	M	High
	CRR2	A	A	M *	B	High
	CRR5	A	A	M	A	High
	COC3	M	A	A	A	High
	CSR3	A	A	A *	A	Very high
	CLR3	A	A	A *	A	Very high
	CLT1	A	A	A	M	Alta High
T4	BDA 1	B	B	B	B	Low
	BDA 2	B	M	B	B	Low
	BAA 1	A	B	A	B	Moderate
	BBP 2	B	A	A	M	High
	BAA 2	A	B	B	M	Moderate
	BAP 1	A	M	A	B	Moderate
	BBM 3	B	B	M	B	Low
	BCA 1	M	B	M	M	Moderate
	BGA 1	A	B	M	B	Moderate
	BBP 7	B	A	A	B	Moderate
	BCP 2	A	M	A	B	Moderate
	BFA 1	A	B	M	B	Moderate
	BGA 1	A	B	A	B	Moderate

Table 9. Partial vulnerability associated with each individual attribute and overall groundwater vulnerability to pollution hazards resulting from the summation of all influential factors. A = high, M = medium and B = low.

Test Area	UBC	Attributes liable to influence vulnerability				Vulnerability Class
		Lithology	Fracturing	Soil type	Declivity	
T3	CSA1	M	M	A	A	High
	CLC1	B	A	B*	M	Low
	CSA2	M	A	A	M	High
	CNC2	B	A	A	M	Moderate
	CRR3	M	M	M	M	Moderate
	CNC1	B	A	M	M	Moderate
	BAC1	A	B	A	M	Moderate
	CRR2	M	A	M*	B	Moderate
	CRR5	M	A	M	B	Moderate
	COC3	B	A	A	M	Moderate
	CSR3	M	A	M*	B	Moderate
	CLR3	M	A	M*	B	Moderate
	CLT1	M	A	A	M	High
T4	BDA 1	B	B	B	A	Low
	BDA 2	B	M	B	A	Low
	BAA 1	A	B	A	M	Moderate
	BBP 2	B	A	M	M	Moderate
	BAA 2	A	B	B	M	Low
	BAP 1	A	M	A	M	High
	BBM 3	A	B	M	A	Moderate
	BCA 1	M	B	A	M	Moderate
	BGA 1	M	B	A	A	Moderate
	BBP 7	M	A	A	M	High
	BCP 2	M	M	A	A	High
	BFA 1	M	B	M	A	Moderate
	BGA 1	M	B	A	A	Moderate