Australian Rivers Institute

Sustainable solutions for rivers, coasts and catchments

A machine learning approach to estimate river bank erosion through multi-temporal LIDAR and spectral imagery

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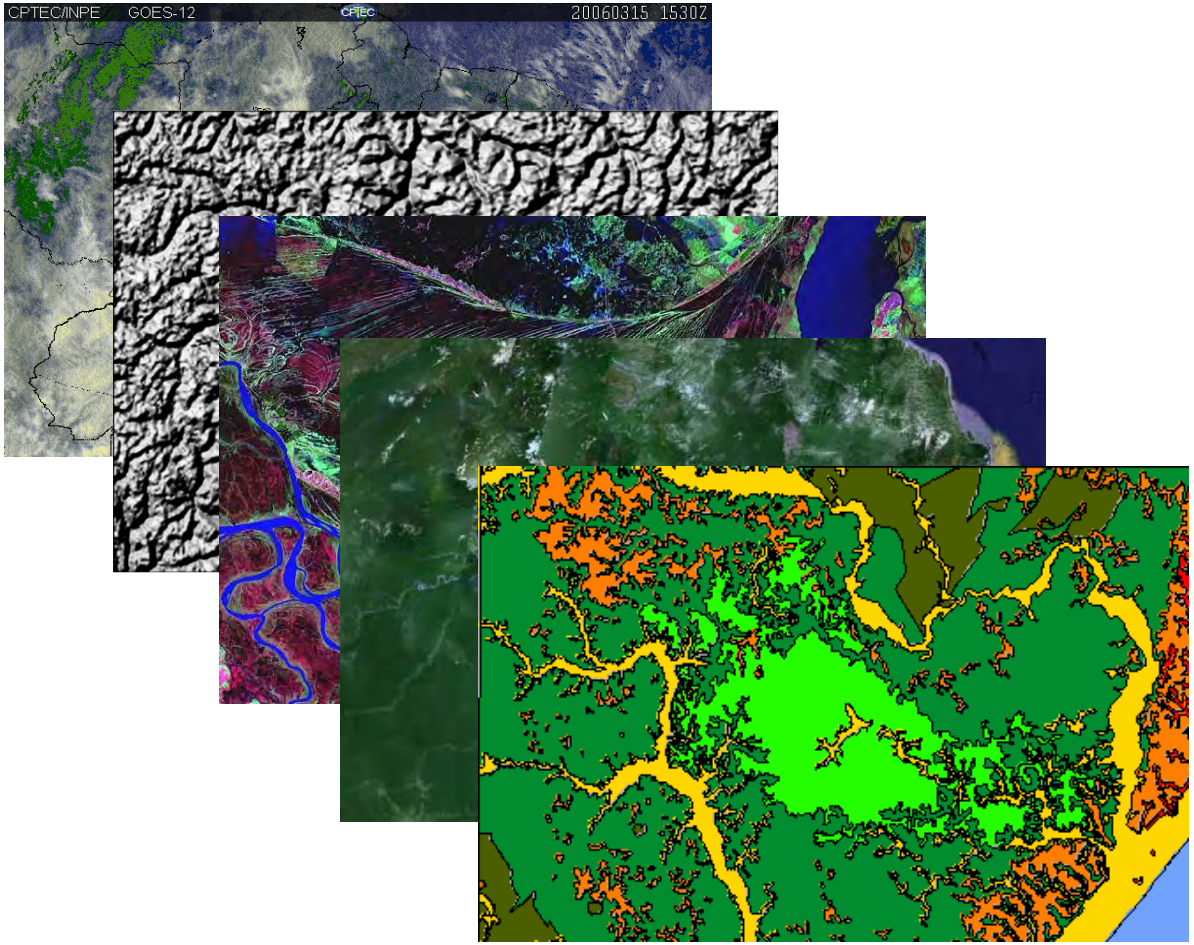
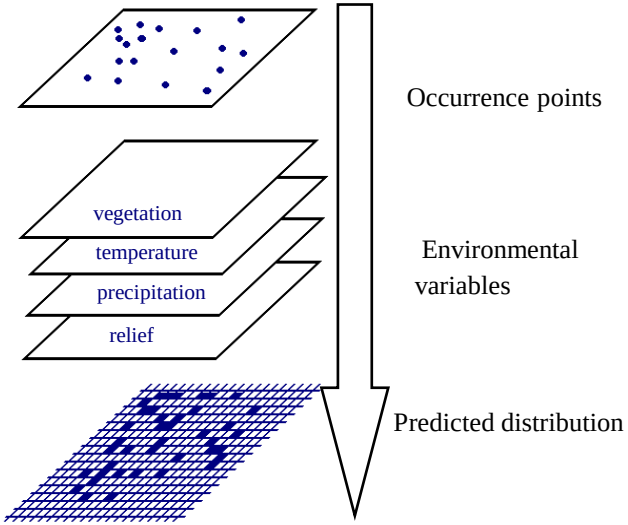
Australian Rivers Institute, Griffith University

Griffith UNIVERSITY

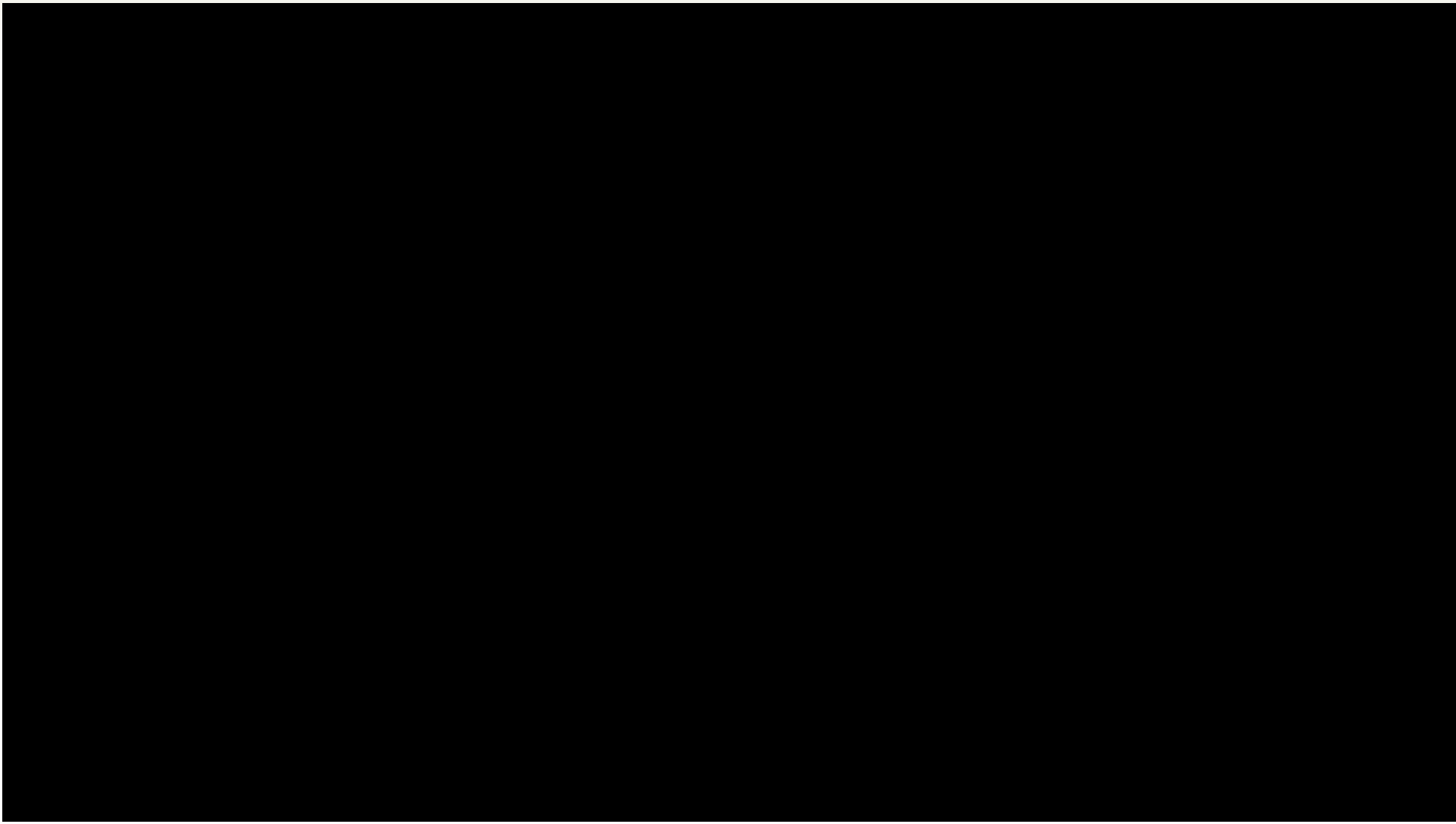
CARING FOR OUR COUNTRY

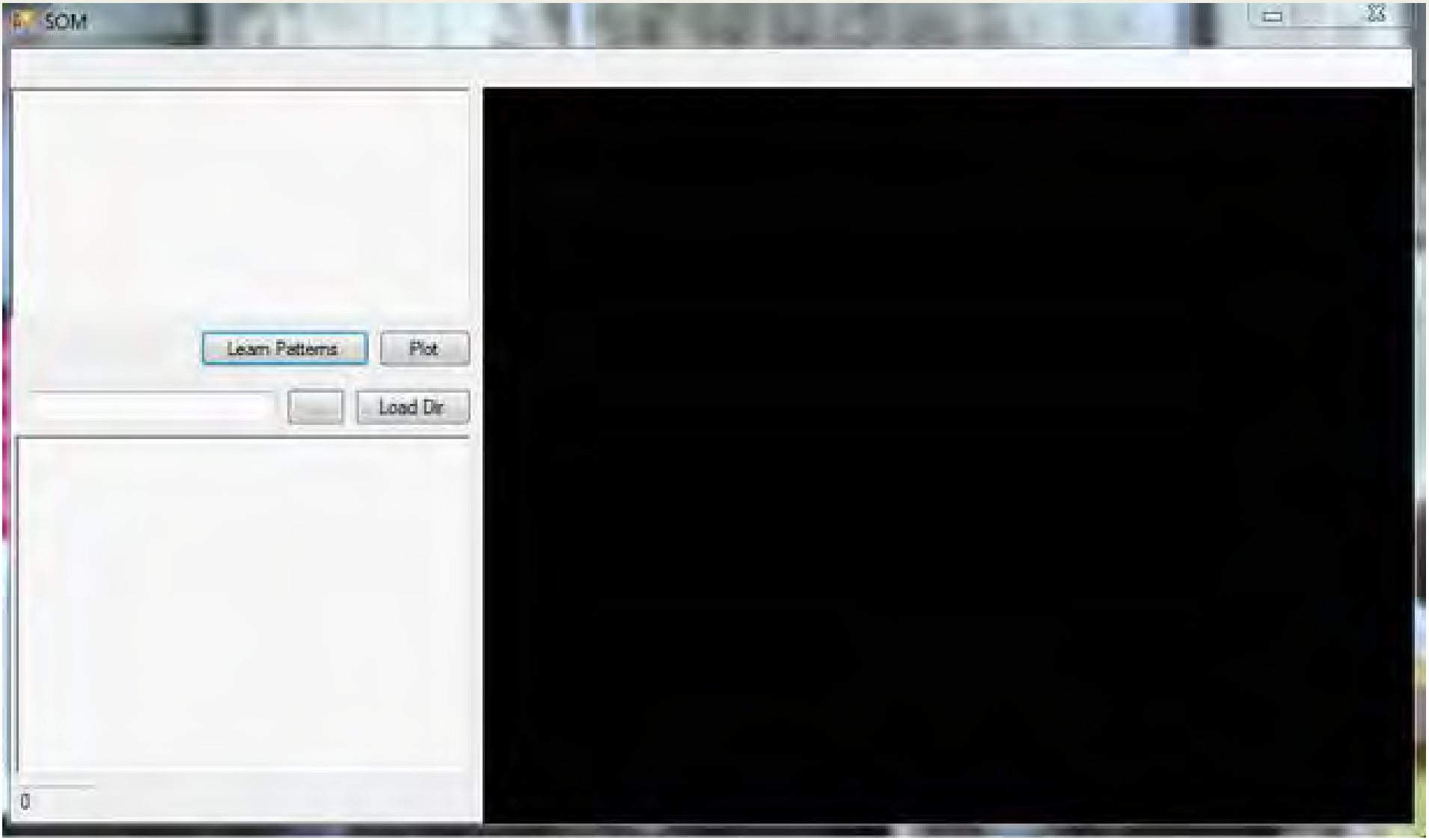
Machine learning





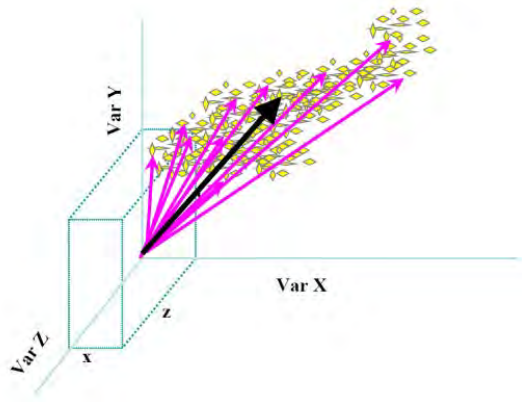
Modified from Scachett (2005)

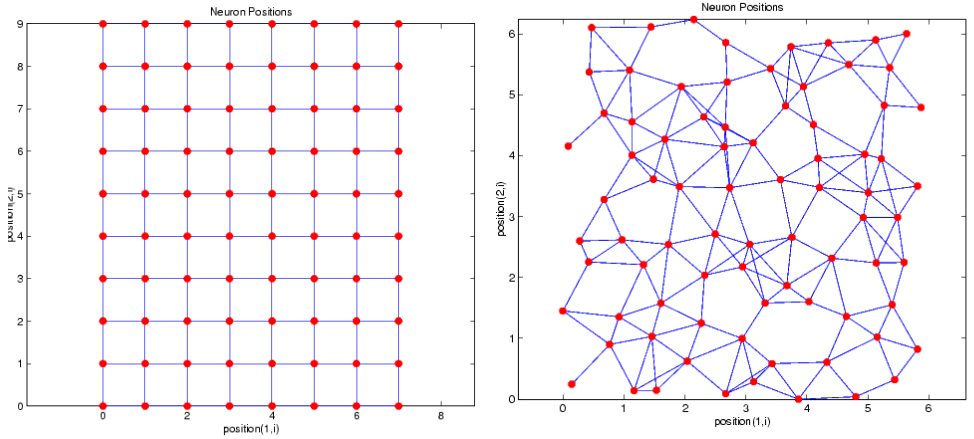



SOM
Learn Patterns
Plot
Load Dir
0

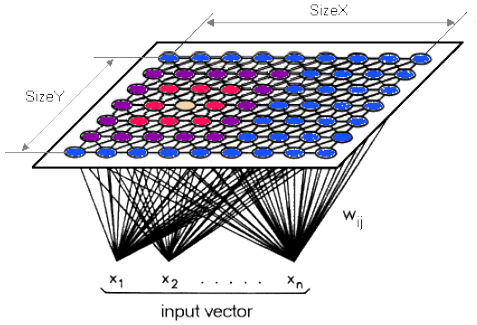
Self organizing maps (SOM)

Each samples is associated to a vector

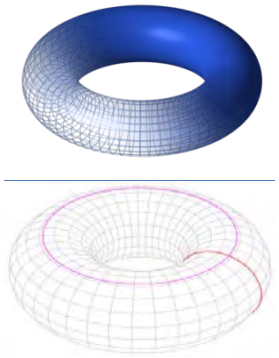


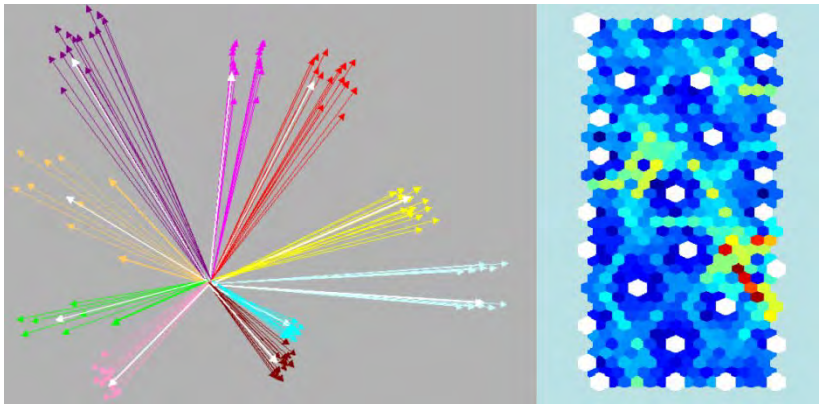


Positions of the samples change, the topology is preserved



Map is projected on a toroid





Variables

Sensor	Metric	Resolution (m)
LIDAR	Erosion	1
SRTM	Elevation	30
	Slope	30
	Drainage area	30
	Range	30
Landsat 5	Ratio B5/B4	30
	Ratio B3/B5	30
	Ratio B3/B2	30
	Ratio B3/B4	30
	Ratio B7/B2	30
	Ratio B3/B1	30
	Irradiance B6	120
	NDVI	30
	Channel depth	
	Channe width	

Landsat 5 - TM

- Order on http://earthexplorer.usgs.gov/
- After 2003 “on demand”

Digital Number to Spectral Reflectance

$$L_\lambda = G_{\text{rescale}} \times Q_{\text{cal}} + B_{\text{rescale}}$$

$$\rho_P = \frac{\Pi \cdot L_\lambda \cdot d^2}{\text{ESUN}_\lambda \cdot \cos\theta_s}$$

$$T = \frac{\text{K2}}{\ln\left(\frac{\text{K1}}{L_\lambda} + 1\right)}$$

Spectral Radiances, $LMIN_\lambda$ and $LMAX_\lambda$ in W/(m².sr. µm)								
Processing Date	From March 1, 1984 To May 4, 2003				After May 5, 2003			
Band	$LMIN_\lambda$	$LMAX_\lambda$	$G_{rescale}$	$B_{rescale}$	$LMIN_\lambda$	$LMAX_\lambda$	$G_{rescale}$	$B_{rescale}$
1	-1.52	152.10	0.602431	-1.52	-1.52	193.0	0.762824	-1.52
2	-2.84	296.81	1.175100	-2.84	-2.84	365.0	1.442510	-2.84
3	-1.17	204.30	0.805765	-1.17	-1.17	264.0	1.039880	-1.17
4	-1.51	206.20	0.814549	-1.51	-1.51	221.0	0.872588	-1.51
5	-0.37	27.19	0.108078	-0.37	-0.37	30.2	0.119882	-0.37
6	1.2378	15.303	0.055158	1.2378	1.2378	15.303	0.055158	1.2378
7	-0.15	14.38	0.056980	-0.15	-0.15	16.5	0.065294	-0.15

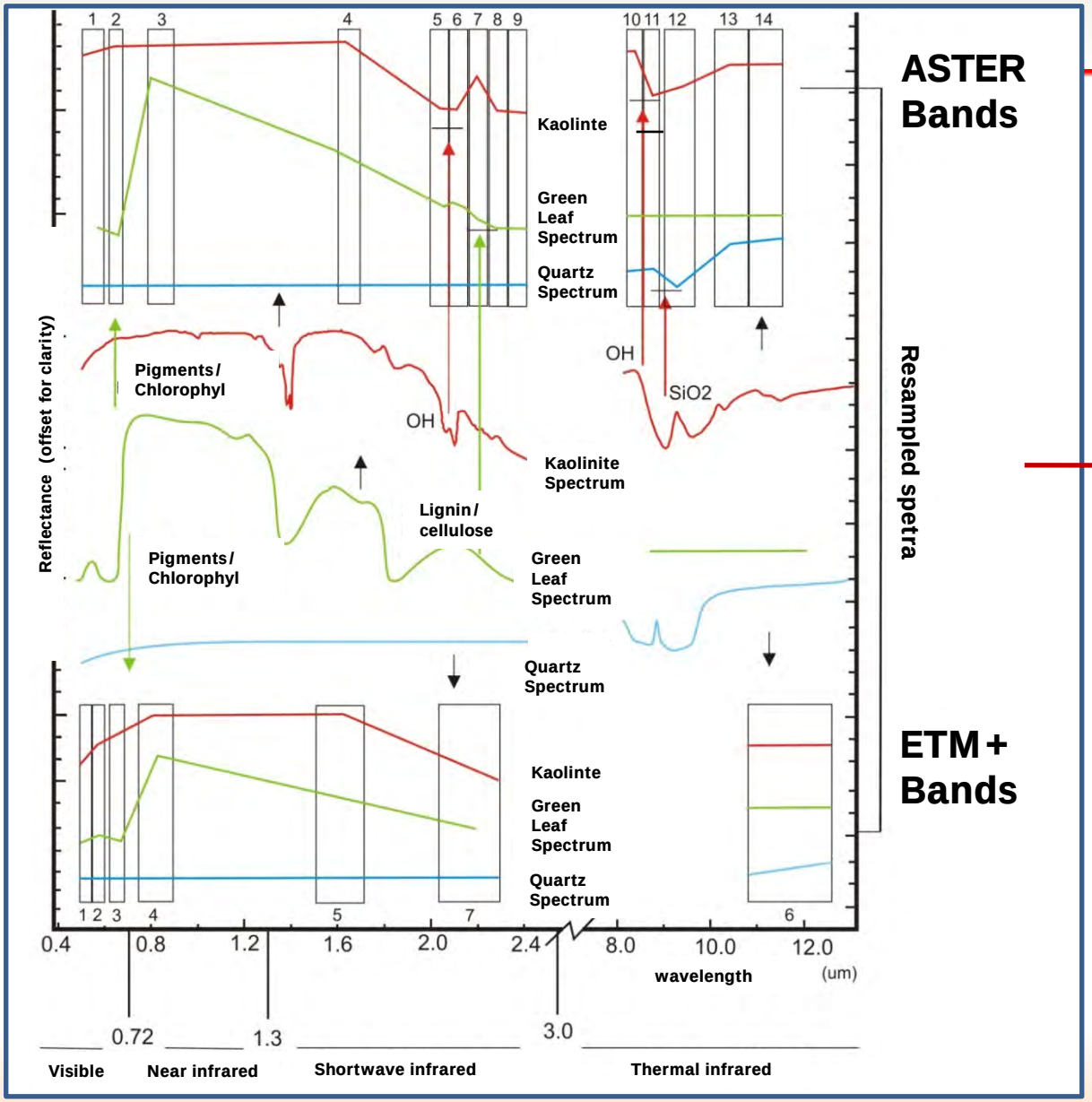
DOY	Distance	DOY	Distance	DOY	Distance
1	0.9832	121	1.0076	242	1.0092
15	0.9836	135	1.0109	258	1.0057
32	0.9853	152	1.014	274	1.0011
46	0.9878	166	1.0158	288	0.9972
60	0.9909	182	1.0167	305	0.9925
74	0.9945	196	1.0165	319	0.9892
91	0.9993	213	1.0149	335	0.986
106	1.0033	227	1.0128	349	0.9843
DOY- Day of Year (Julian Day)				365	0.9833

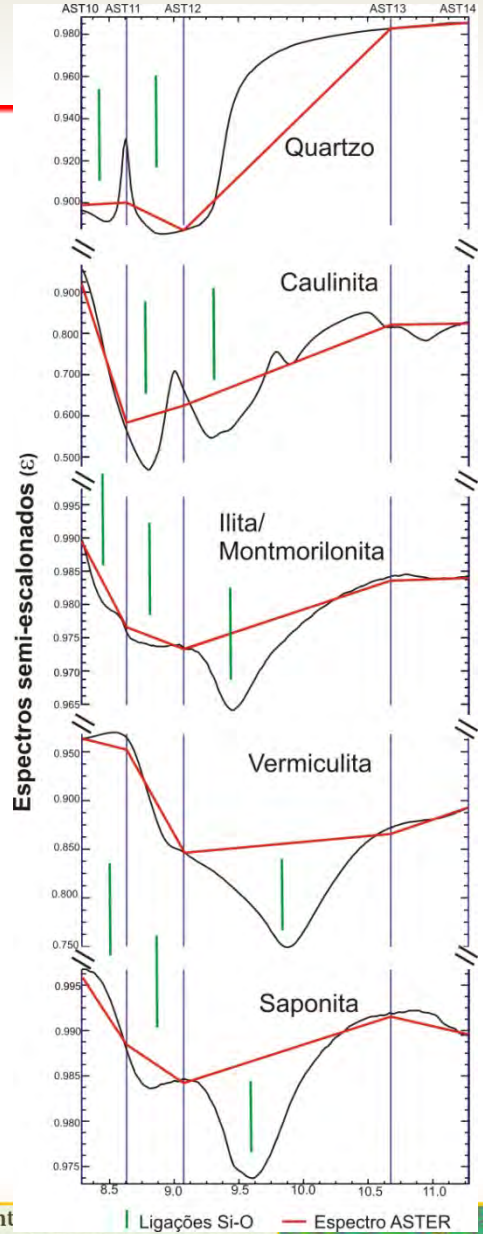
Units: ESUN = W/(m². µm)		
Model:	Chance Spectrum CHKUR	
Band	Landsat 4	Landsat 5
1	1957	1957
2	1825	1826
3	1557	1554
4	1033	1036
5	214.9	215.0
7	80.72	80.67

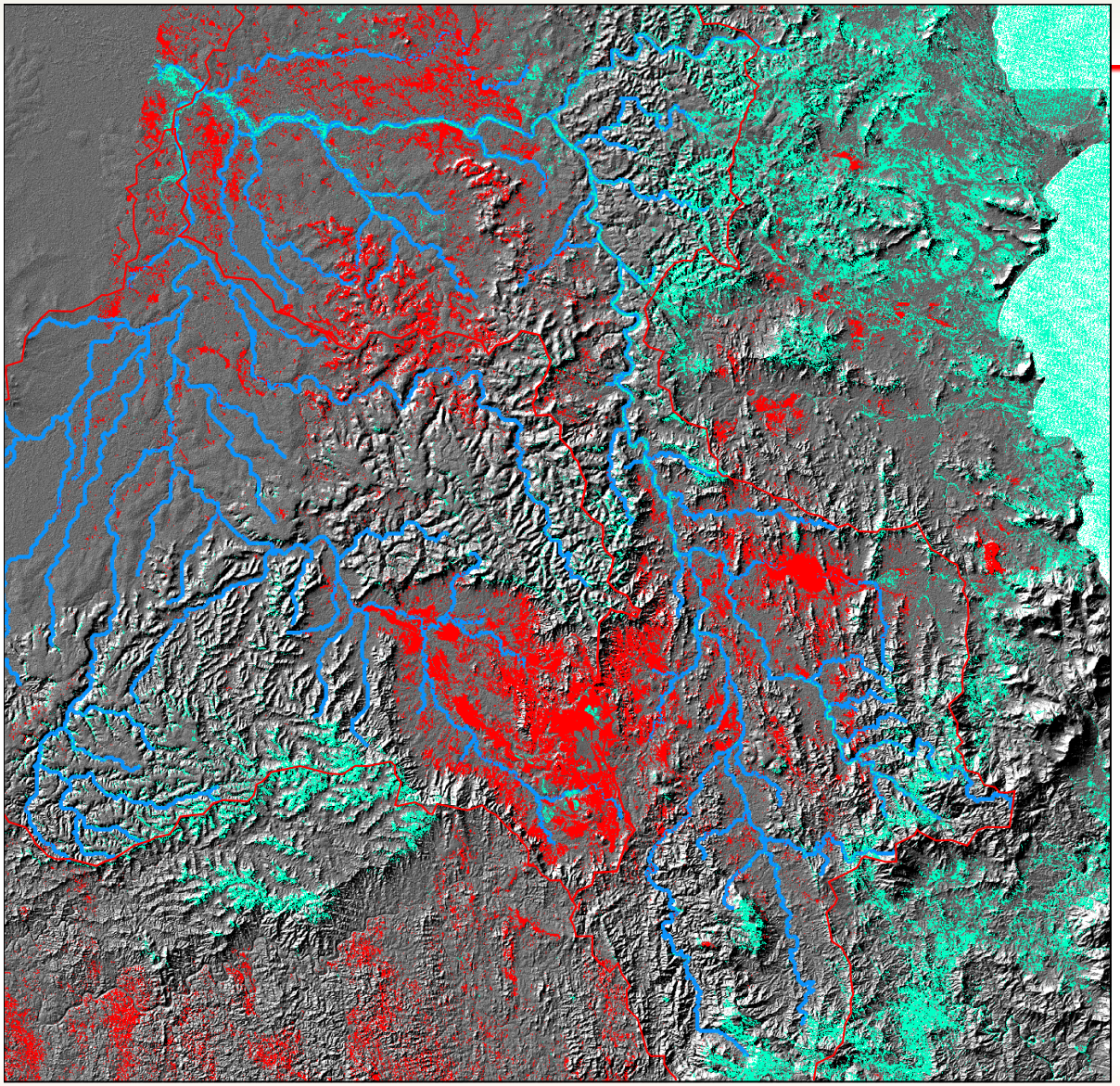
TM THERMAL BAND CALIBRATION CONSTANTS

Units	W/(m².sr. µm)	Kelvin
Constant	K1	K2
Landsat 4	671.62	1284.30
Landsat 5	607.76	1260.56

Band ratios


ASTER Bands
ETM+ Bands
Resampled spetra
Reflectance (offset for clarity)
Kaolinte
Green Leaf Spectrum
Quartz Spectrum
Pigments/ Chlorophyl
OH
SiO2
Kaolinite Spectrum
Lignin/ cellulose
0.4
0.8
1.2
1.6
2.0
2.4
8.0
10.0
12.0
wavelength
(um)
0.72
1.3
3.0
Visible
Near infrared
Shortwave infrared
Thermal infrared

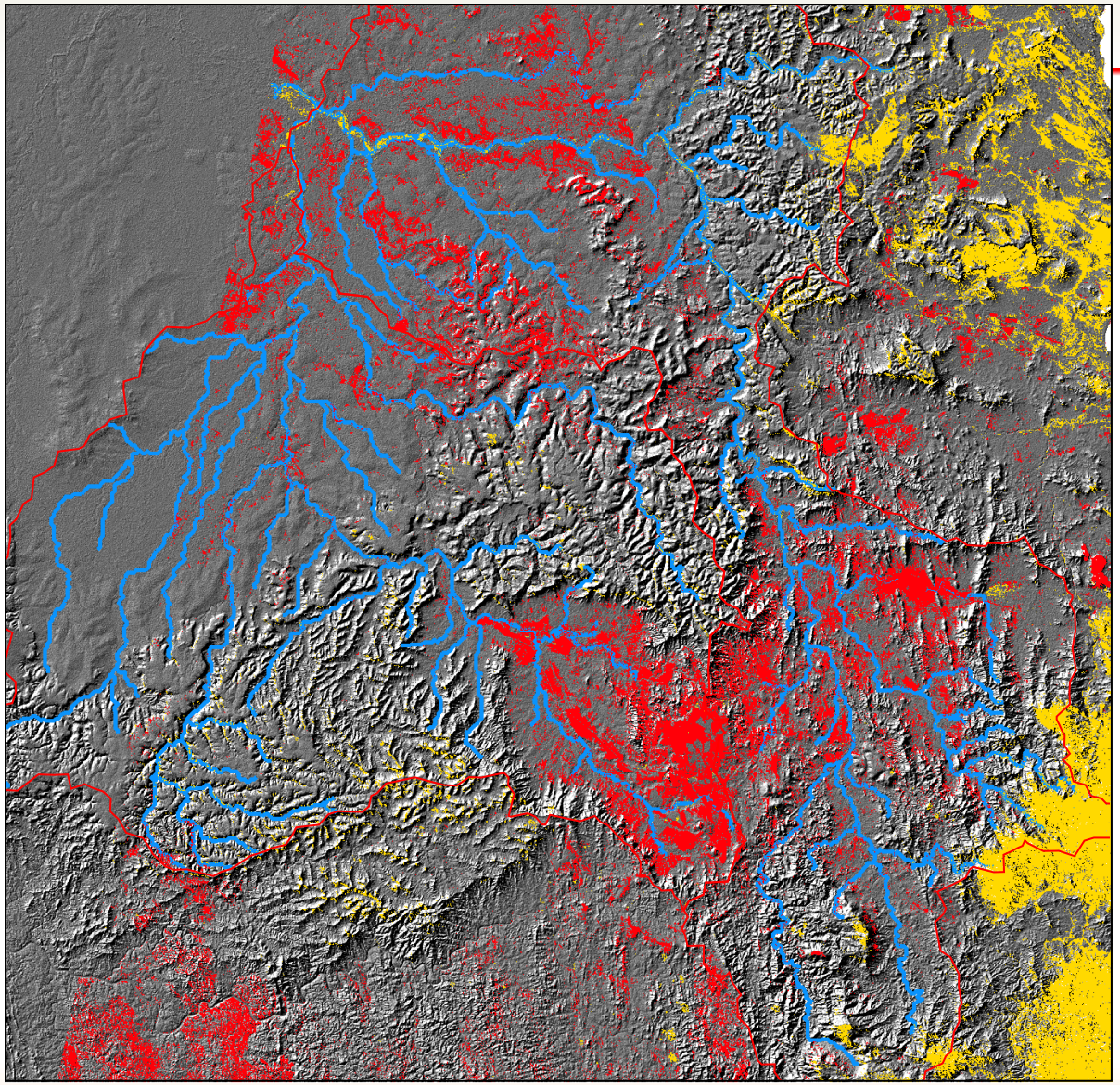

AST10 AST11 AST12 AST13 AST14
Quartzo
Caulinita
Ilita/ Montmorilonita
Vermiculita
Saponita
Espectros semi-escalonados (ε)
Ligações Si-O
Espectro ASTER



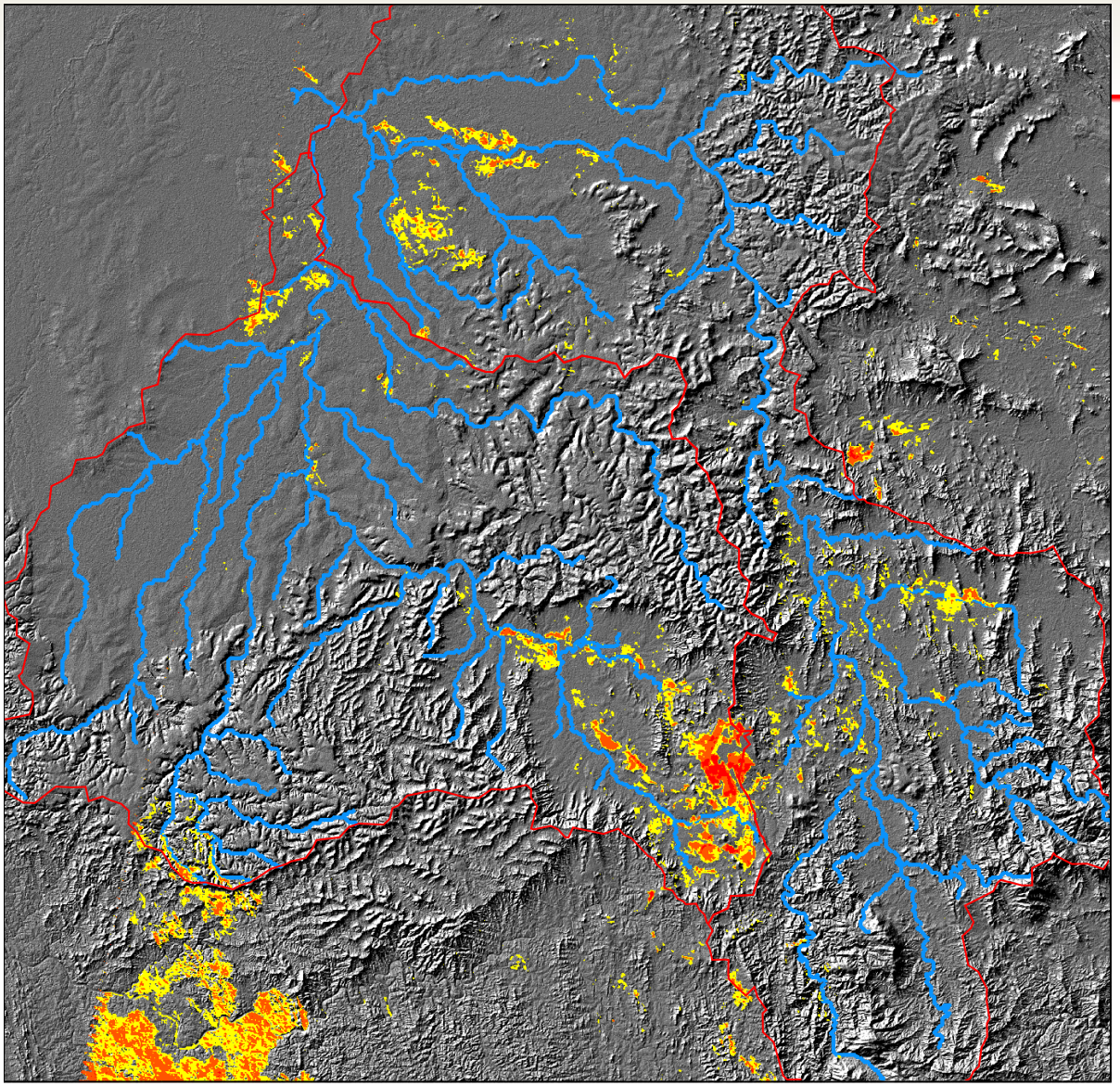
Ratio B5B4

soil moisture,
water body,
vegetation,
barren lands,

Ratio B7B2



- soil moisture,
  water body,
  vegetation,
  barren lands,



Band 6

Thermal infra-red Irradiance

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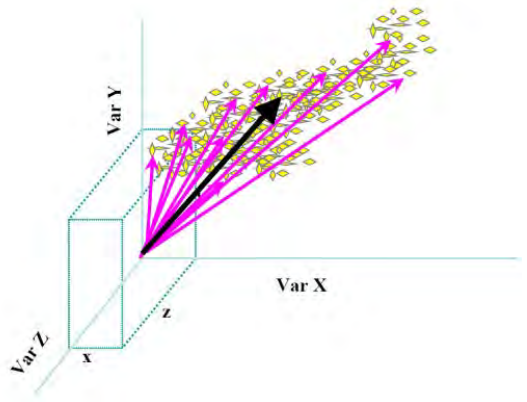

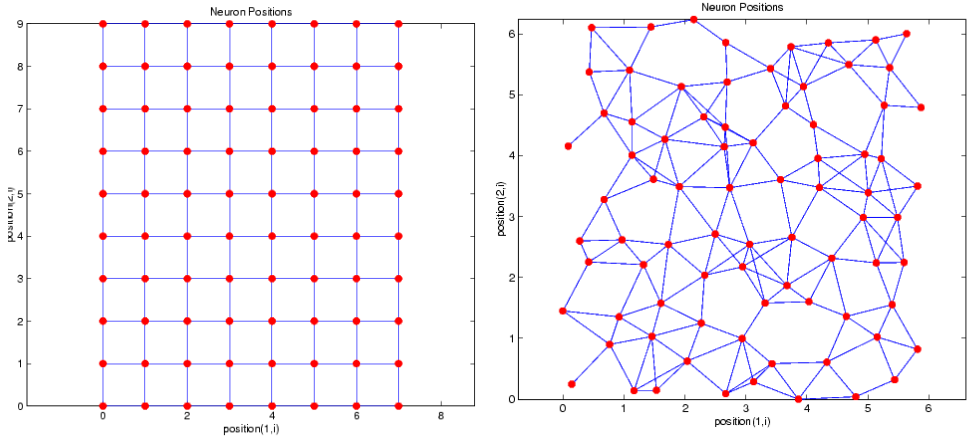

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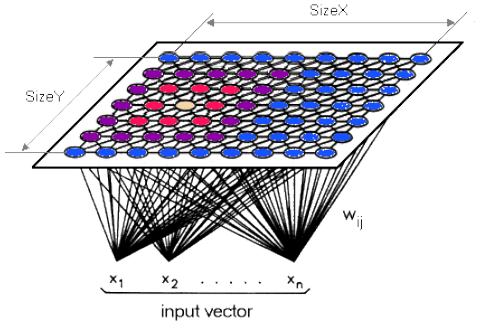

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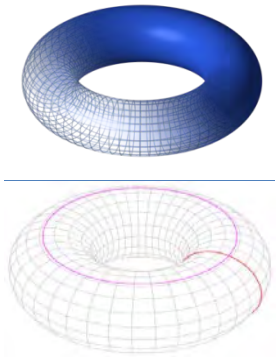
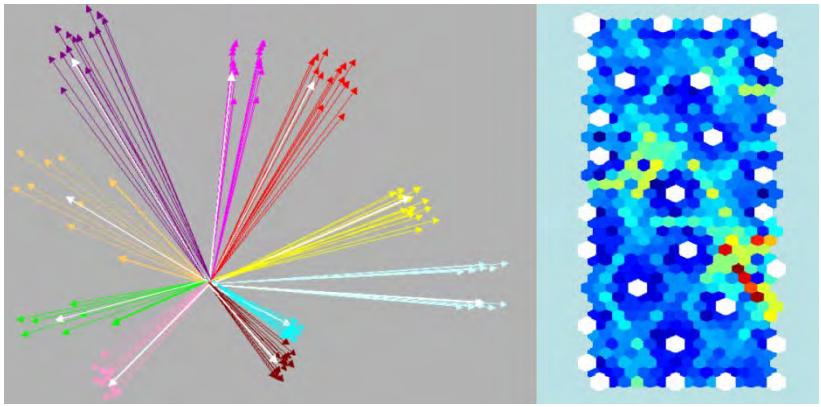
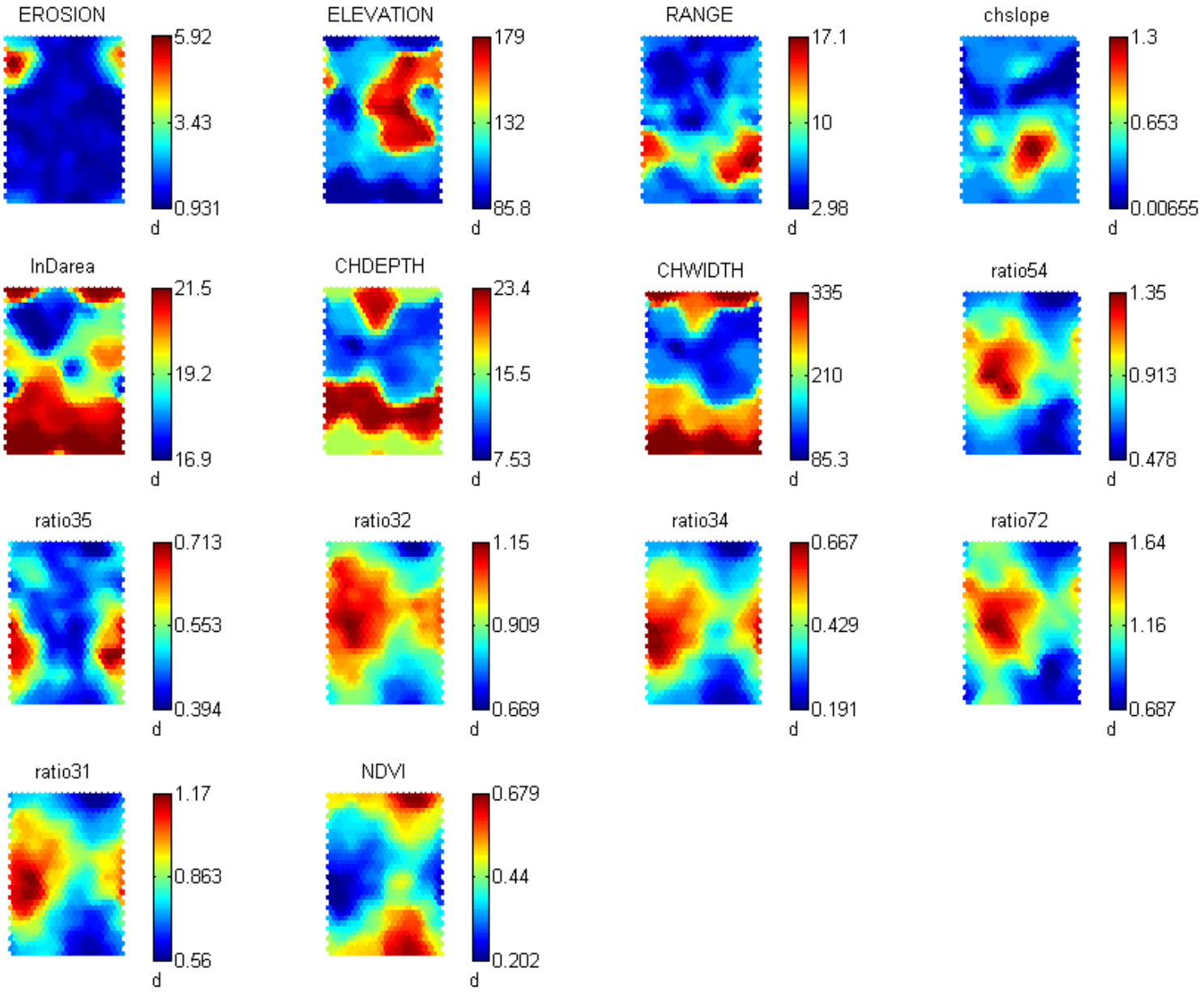
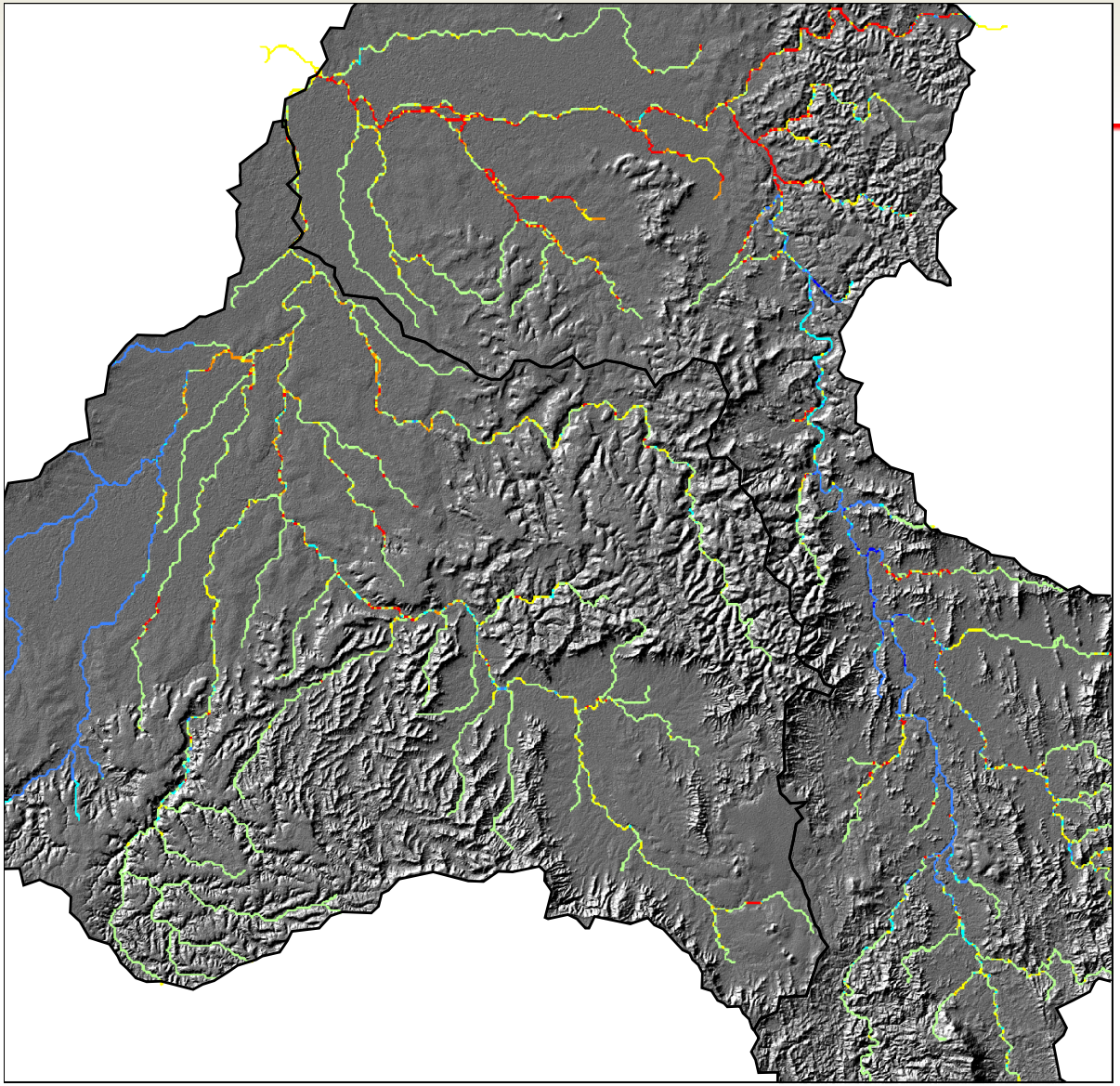





EROSION
5.92
3.43
0.931
d
ELEVATION
179
132
85.8
d
RANGE
17.1
10
2.98
d
chslope
1.3
0.653
0.00655
d
lnDarea
21.5
19.2
16.9
d
CHDEPTH
23.4
15.5
7.53
d
CHWIDTH
335
210
85.3
d
ratio54
1.35
0.913
0.478
d
ratio35
0.713
0.553
0.394
d
ratio32
1.15
0.909
0.669
d
ratio34
0.667
0.429
0.191
d
ratio72
1.64
1.16
0.687
d
ratio31
1.17
0.863
0.56
d
NDVI
0.679
0.44
0.202
d



Erosion

Conclusions

- Results show an increasing trend of erosion from the headwaters to the lower reaches associated with bank retreat due to mass failures.
- Anomalous high values of erosion in the upper basin are likely related to alluvial gully erosion as observed during our fieldwork.