

# **Detecção de Lâmina de Água em Imagens de Satélite por um Método Computacionalmente Simples Baseado em Componente de Matiz**

*Aplicações em Mapeamento, Monitoramento  
e Detecção de Mudanças*

Laércio Massaru Namikawa  
Thales Sehn Körting  
Emiliano Ferreira Castejon

**Referata Geoinformática**  
**09/09/2016**

Paper RBC - GeoInfo 2015

WATER BODY EXTRACTION FROM RAPIDEYE  
IMAGES: AN AUTOMATED METHODOLOGY  
BASED ON HUE COMPONENT OF COLOR  
TRANSFORMATION FROM RGB TO HSV  
MODEL

Laércio Massaru Namikawa  
Thales Sehn Körting  
Emiliano Ferreira Castejon

INPE - National Institute for Space Research  
OBT - Earth Observation Coordination  
DPI - Image Processing Division

# Why?

For water management and flood studies

Changes in water availability due to natural anthropogenic factors

Nation wide coverage using RapidEye tiles:

15000 to 20000 multispectral (5 band with 16 bit each) images to be processed to detect water bodies

fast and independent of expert input



Data SIO, NOAA, U.S. Navy, NGA, GEBCO

Image Landsat

Google earth

# Method

Use of thresholding of the Hue RGB to HSV is a better solution when compared to the other simple and fast methods:

- single IR band thresholding

- use of NDWI (NIR and Green) and MNDWI (IR and Green) thresholding

# Imagens RapidEye

Jacareí/São José (10/Out/2014) e Foz (08/Ago/2014)

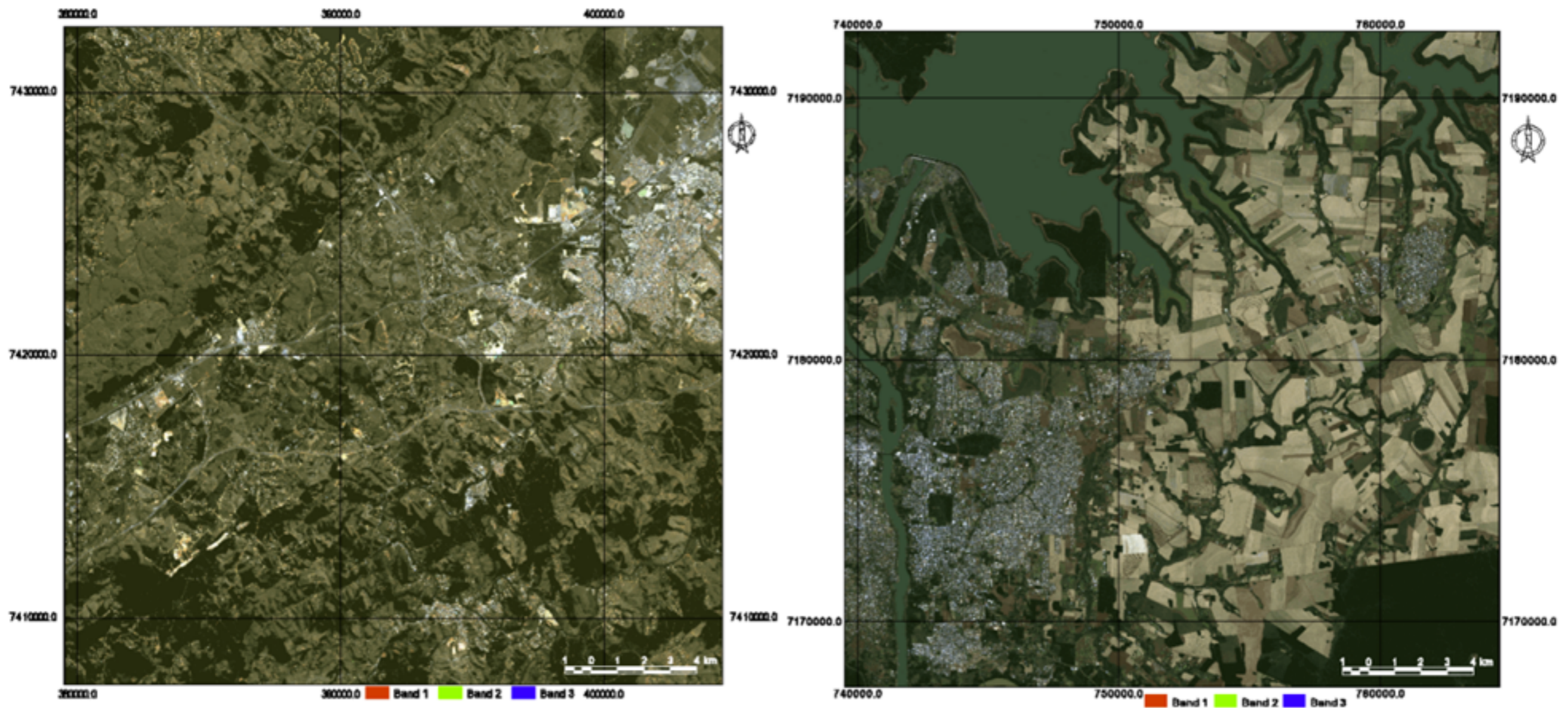


Fig. 1 - Selected images in R3G2B1 enhanced color composition with UTM projection in Datum WGS-84. Left image is over Jacareí, with UTM zone 23 south and right image is over Foz do Iguaçu, with UTM zone 21 south.

# Classificação

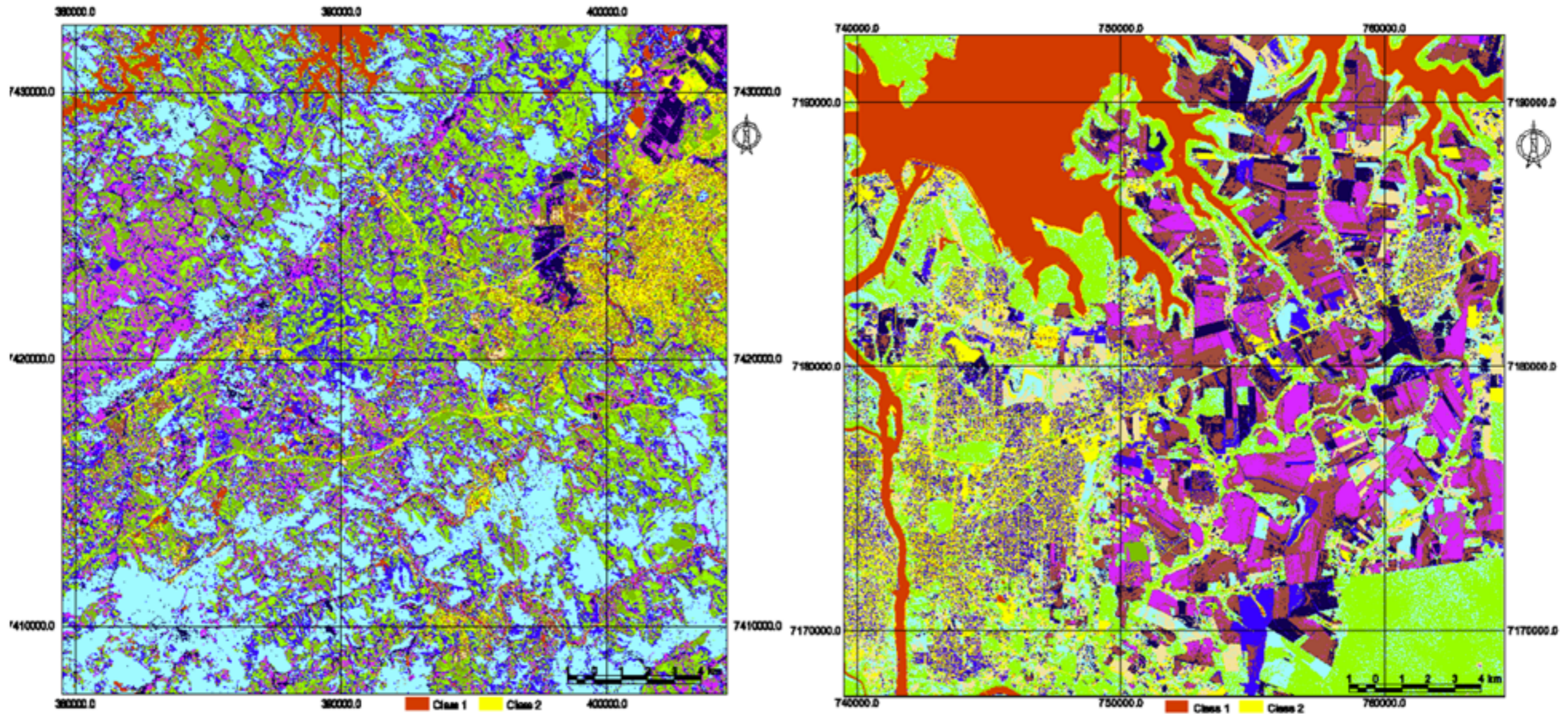


Fig. 2 - Unsupervised classification results using K-Means for both test areas shown in Fig. 1. We used  $K = 10$ , and 10 iterations each execution. Water bodies are presented in red color in both results and yellow color represents dark areas. Other colors represent other types of features.

# Limiar Banda IR (5)

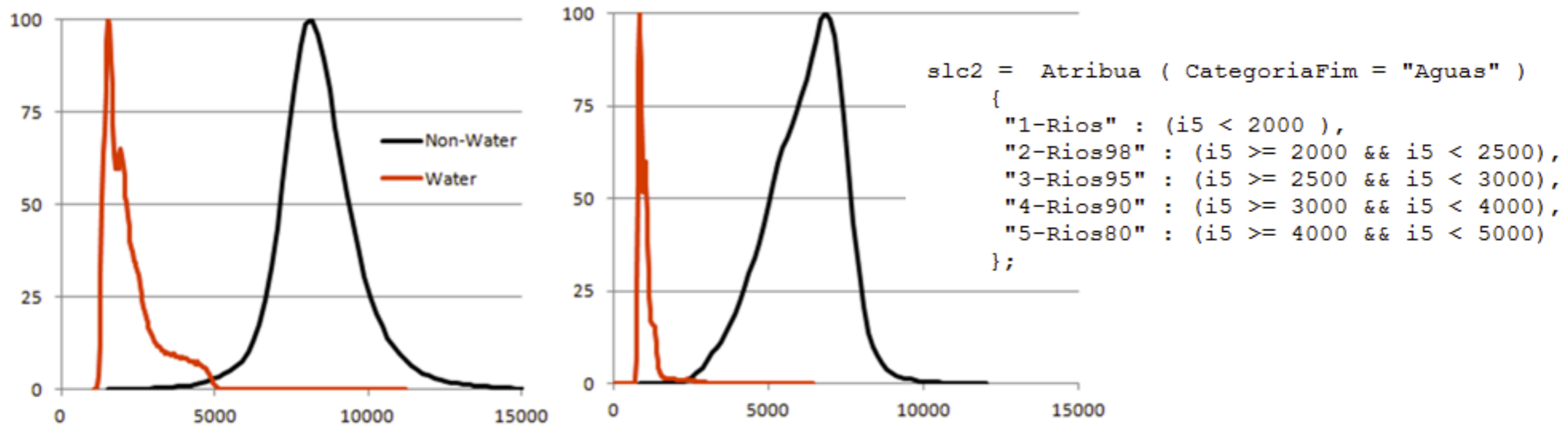
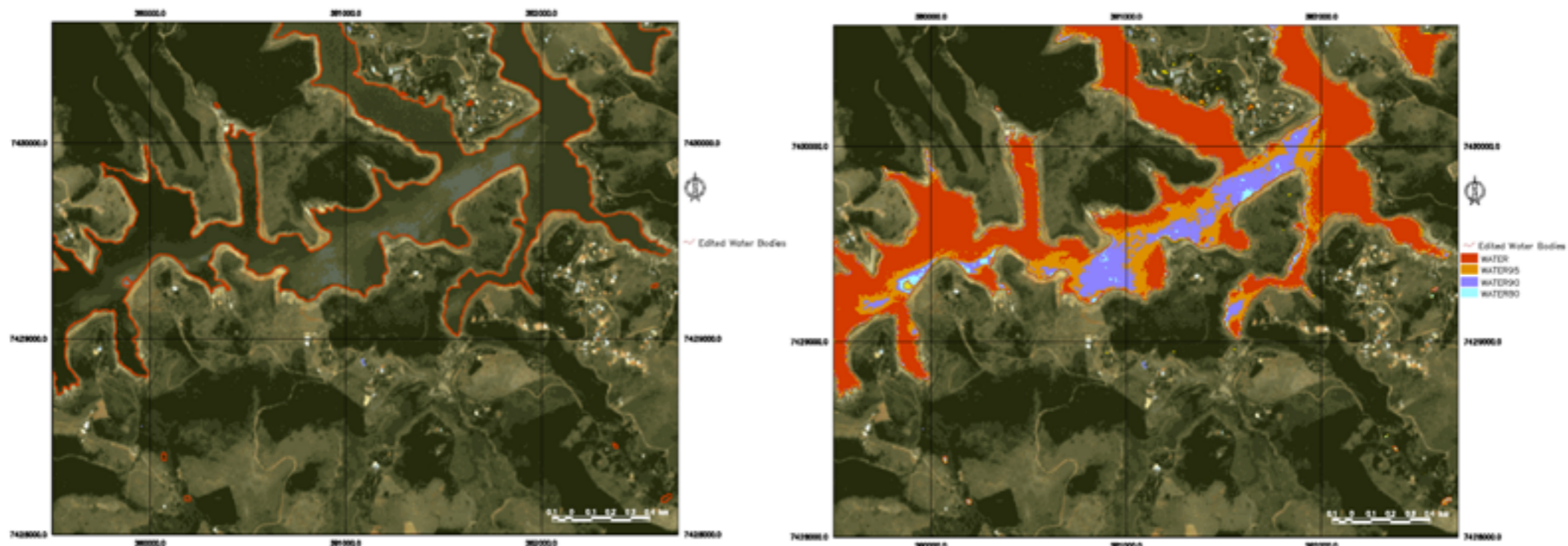
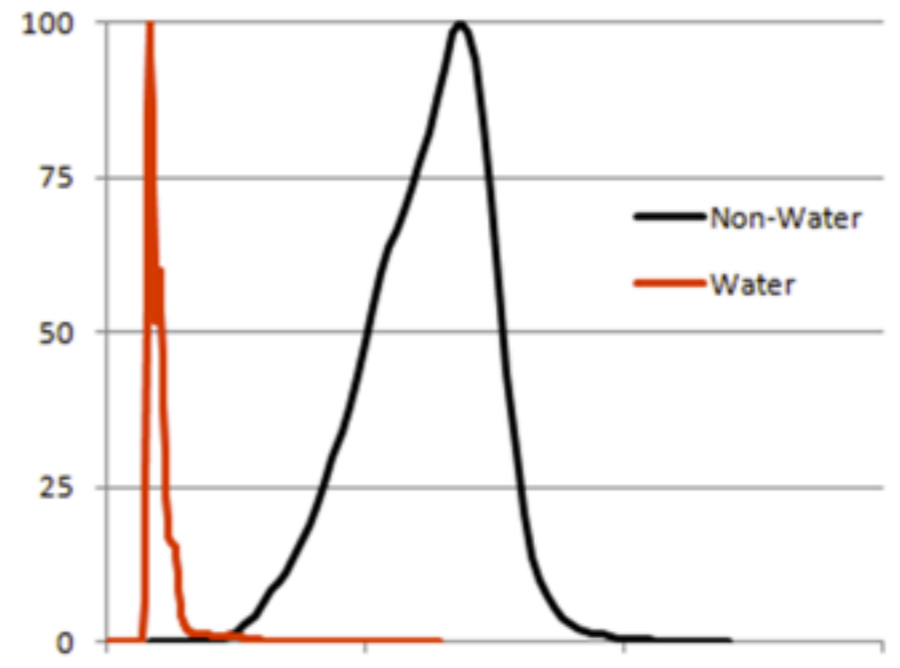
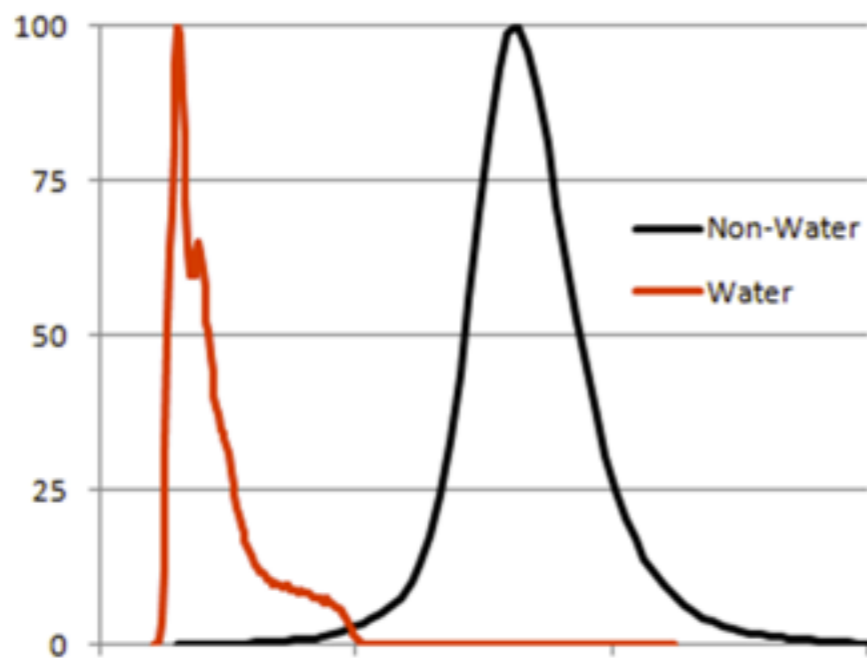


Fig. 3 - Histograms of RapidEye band 5 of Jacareí (left) and Foz do Iguaçu (right) images, highlighting pixels detected as Water (in red) versus other classes (Non-Water).





# Limiar Banda IR (5)



# NDWI (B2-B5)/(B2+B5)

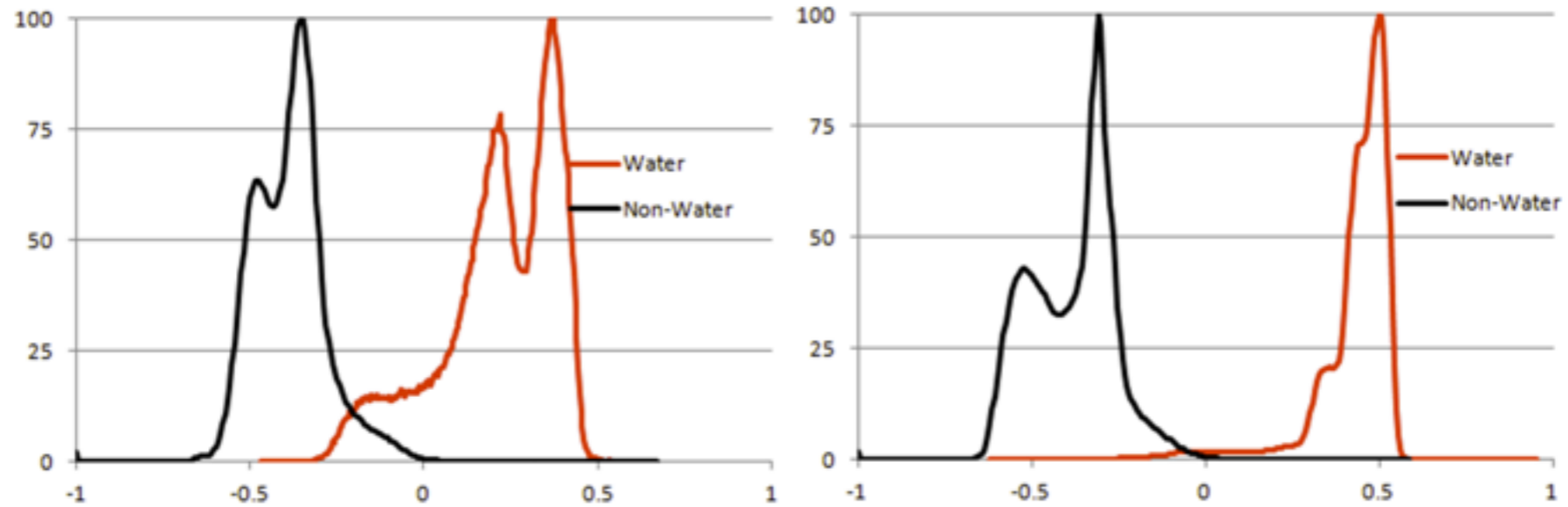
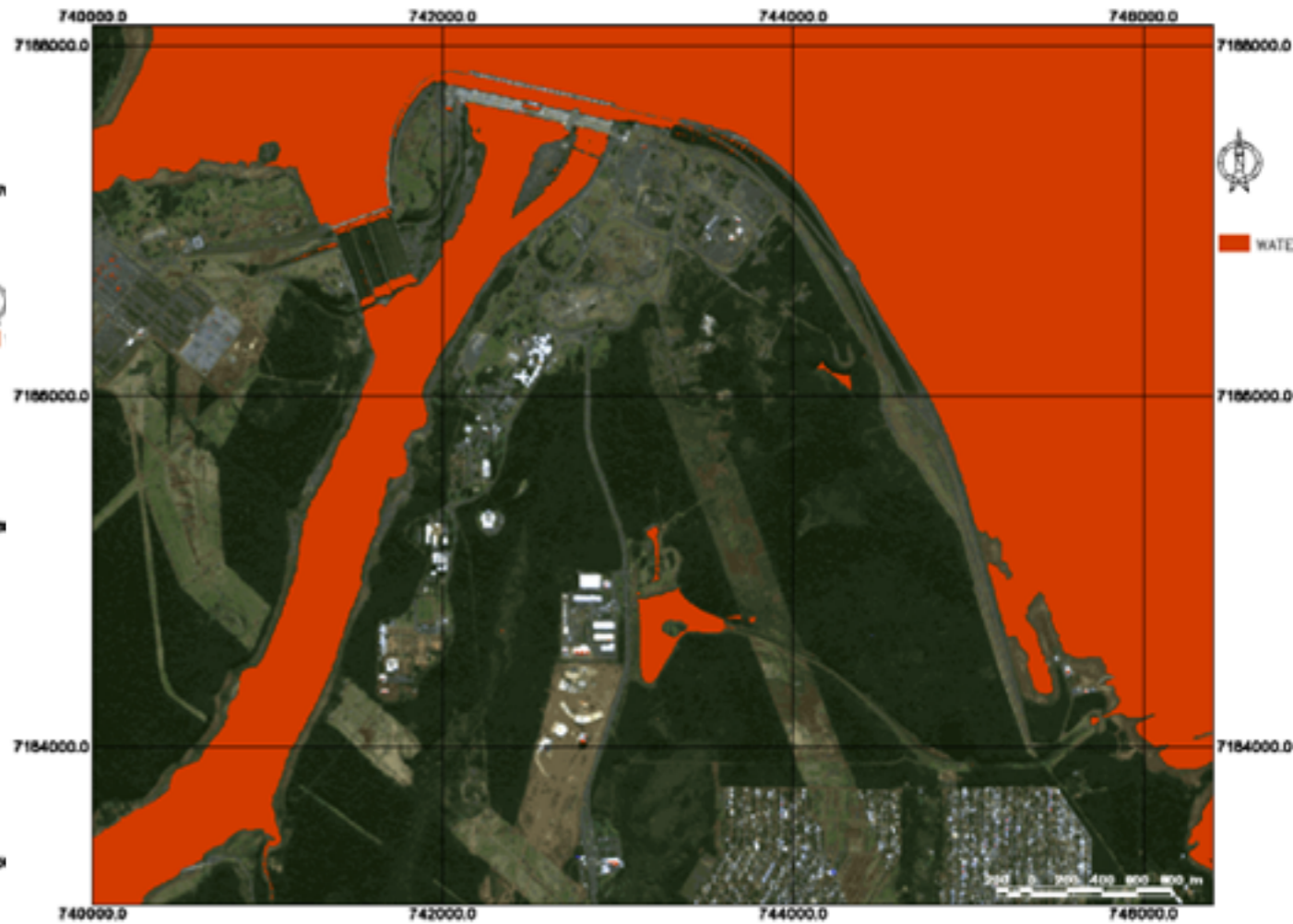
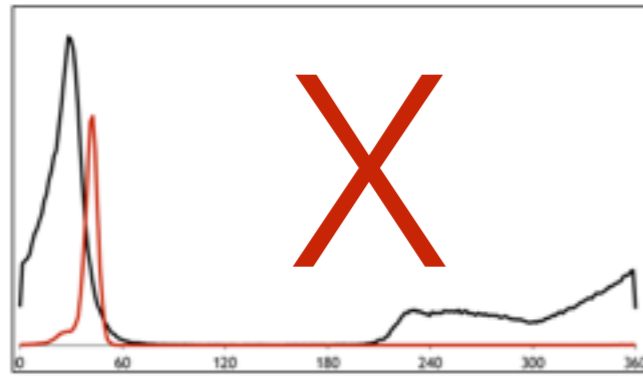


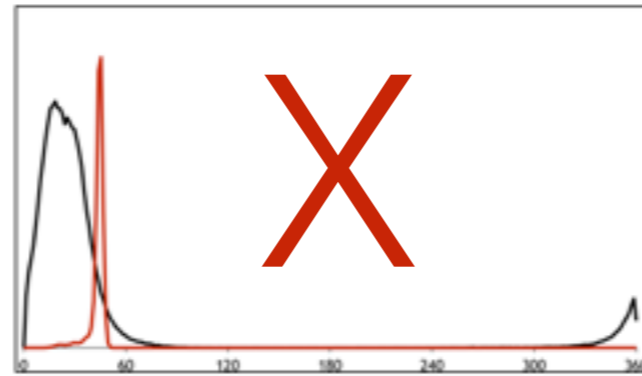
Fig. 6 - Histograms of RapidEye NDWI of Jacareí (left) and Foz do Iguazu (right) images, highlighting pixels detected as Water (in red) versus other classes (Non-Water).



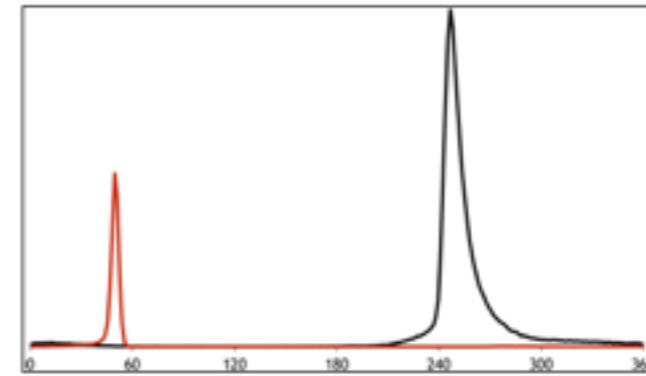
# Histogram - H Component



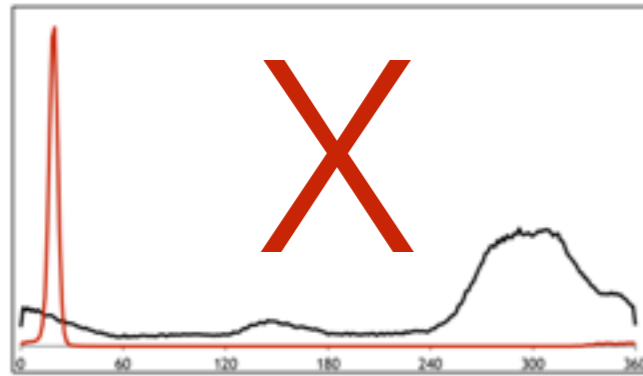
a) H123 - Hue from R1G2B3



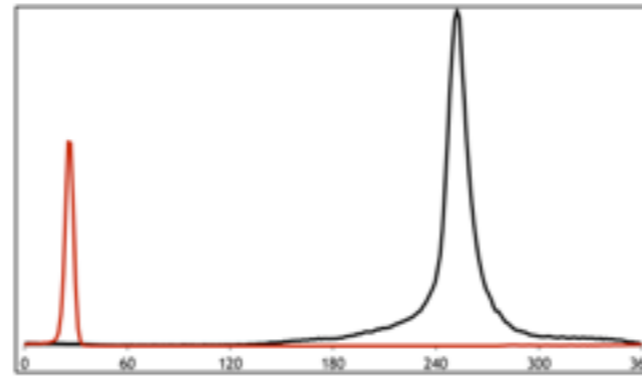
b) H124 - Hue from R1G2B4



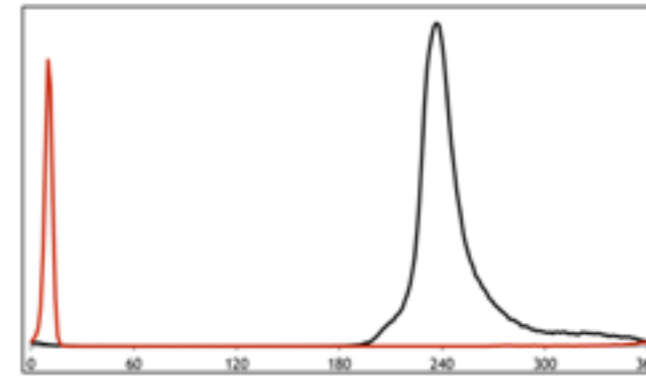
c) H125 - Hue from R1G2B5



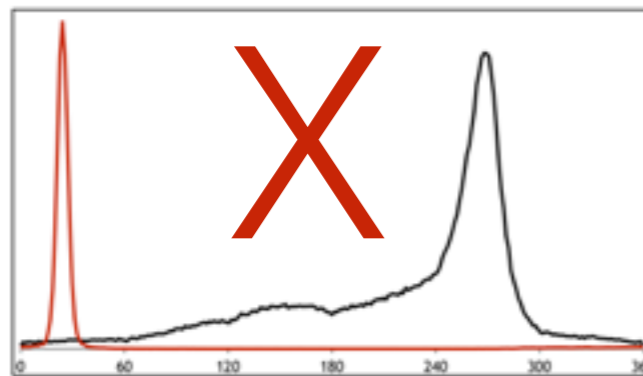
d) H134 - Hue from R1G3B4



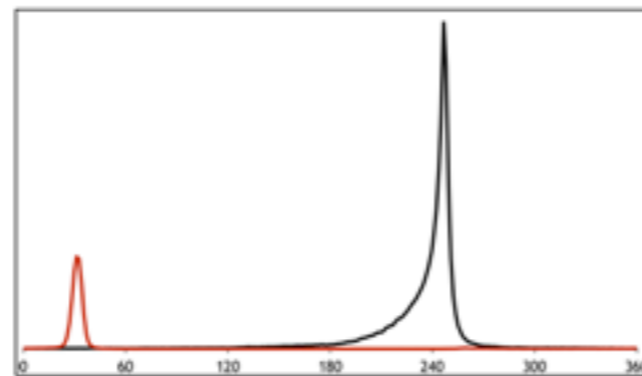
e) H135 - Hue from R1G3B5



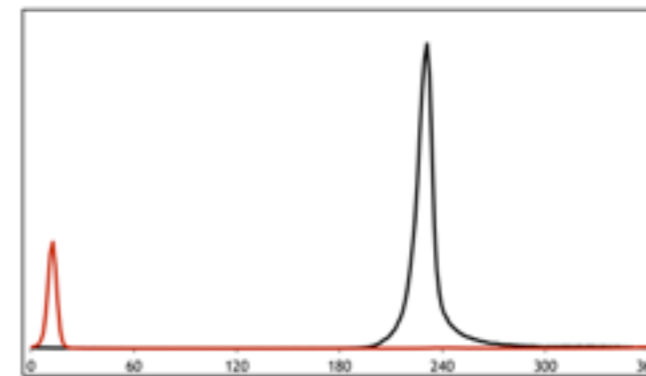
f) H145 - Hue from R1G4B5



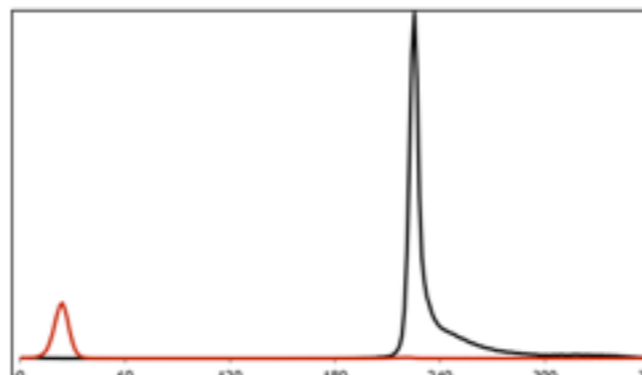
g) H234 - Hue from R2G3B4



h) H235 - Hue from R2G3B5



i) H245 - Hue from R2G4B5



j) H345 - Hue from R3G4B5

Hue from color composition	Non-Water Pixels in Water Percentile Range			Water Pixels in Non-Water Percentile Range		
	90%	95%	98%	90%	95%	98%
R1G2B5	992 (0.37%)	3773 (1.41%)	16145 (6.02%)	199 (0.44%)	527 (1.17%)	1012 (2.24%)
R1G3B5	1446 (0.54%)	4460 (1.66%)	14540 (5.42%)	92 (0.20%)	691 (1.53%)	2497 (5.53%)
R1G4B5	862 (0.32%)	3861 (1.44%)	15288 (5.70%)	198 (0.44%)	509 (1.12%)	920 (2.04%)
R2G3B5	511 (0.19%)	1900 (0.71%)	2633 (0.98%)	52 (0.12%)	345 (0.76%)	33658 (74.52%)
R2G4B5	238 (0.20%)	3547 (1.32%)	23313 (8.69%)	437 (0.97%)	685 (1.52%)	992 (2.20%)
R3G4B5	886 (0.33%)	127582 (47.55%)	265274 (98.86%)	722 (1.60%)	971 (2.15%)	1367 (3.72%)

Hue from color composition	Non-Water in Water		Water in Non-Water		Index
	90%	95%	90%	95%	
R1G2B5	0,37%	1,41%	0,44%	1,17%	3.39
R1G3B5	0,54%	1,66%	0,20%	1,53%	3.93
R1G4B5	0,32%	1,44%	0,44%	1,12%	3.32
R2G3B5	0,19%	0,71%	0,12%	0,76%	1.78
R2G4B5	0,20%	1,32%	0,97%	1,52%	4.01
R3G4B5	0,33%	47,55%	1,60%	2,15%	51.68

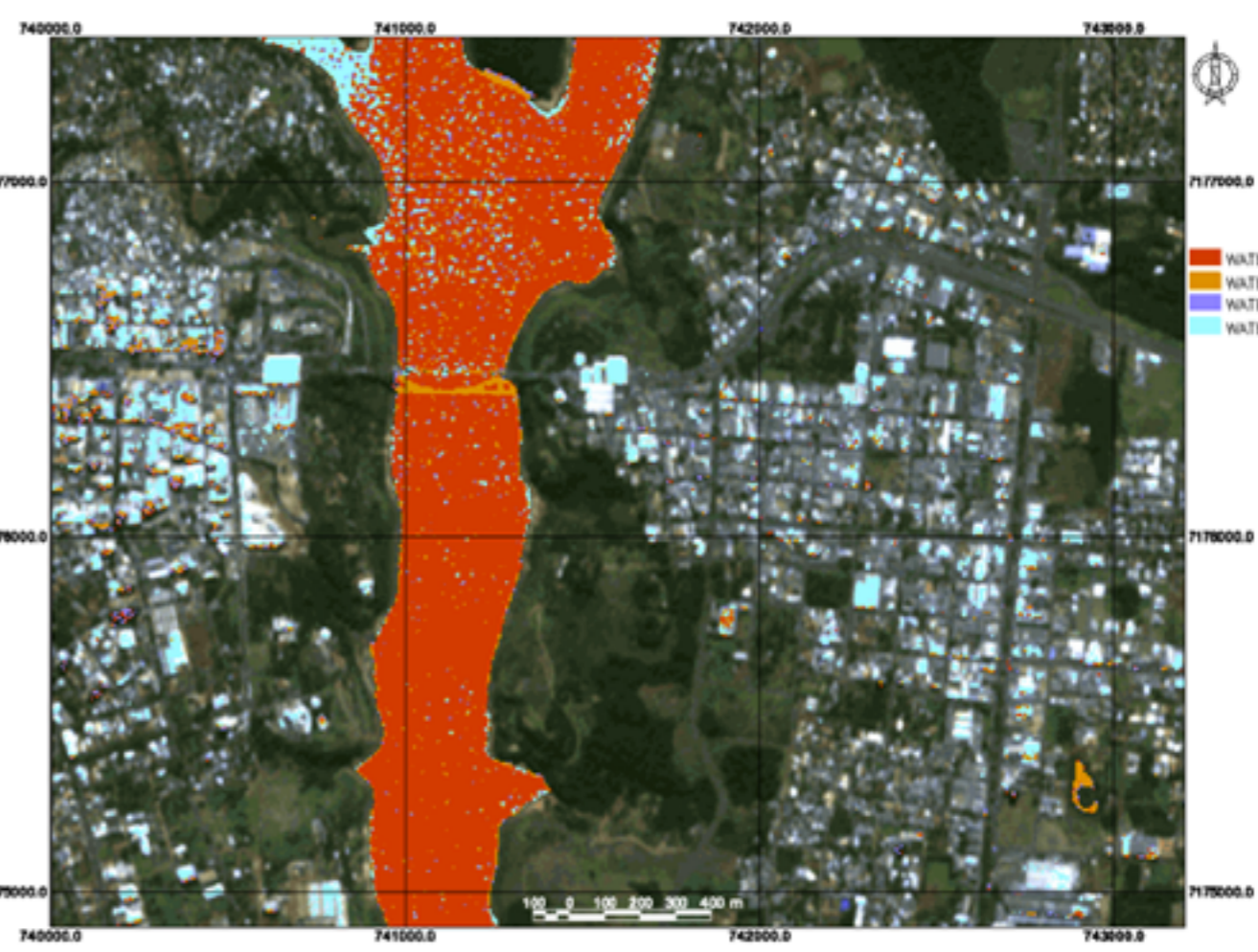
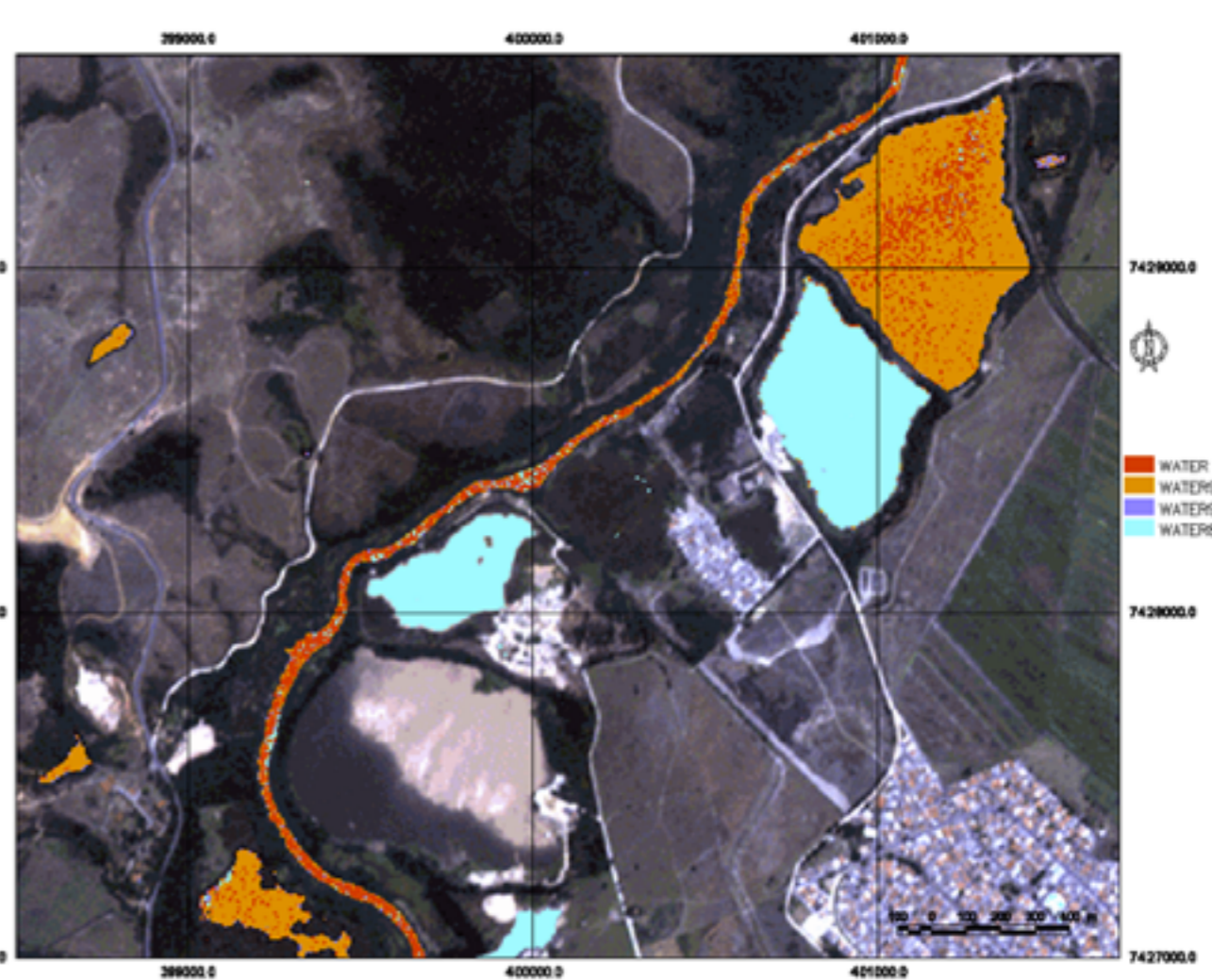
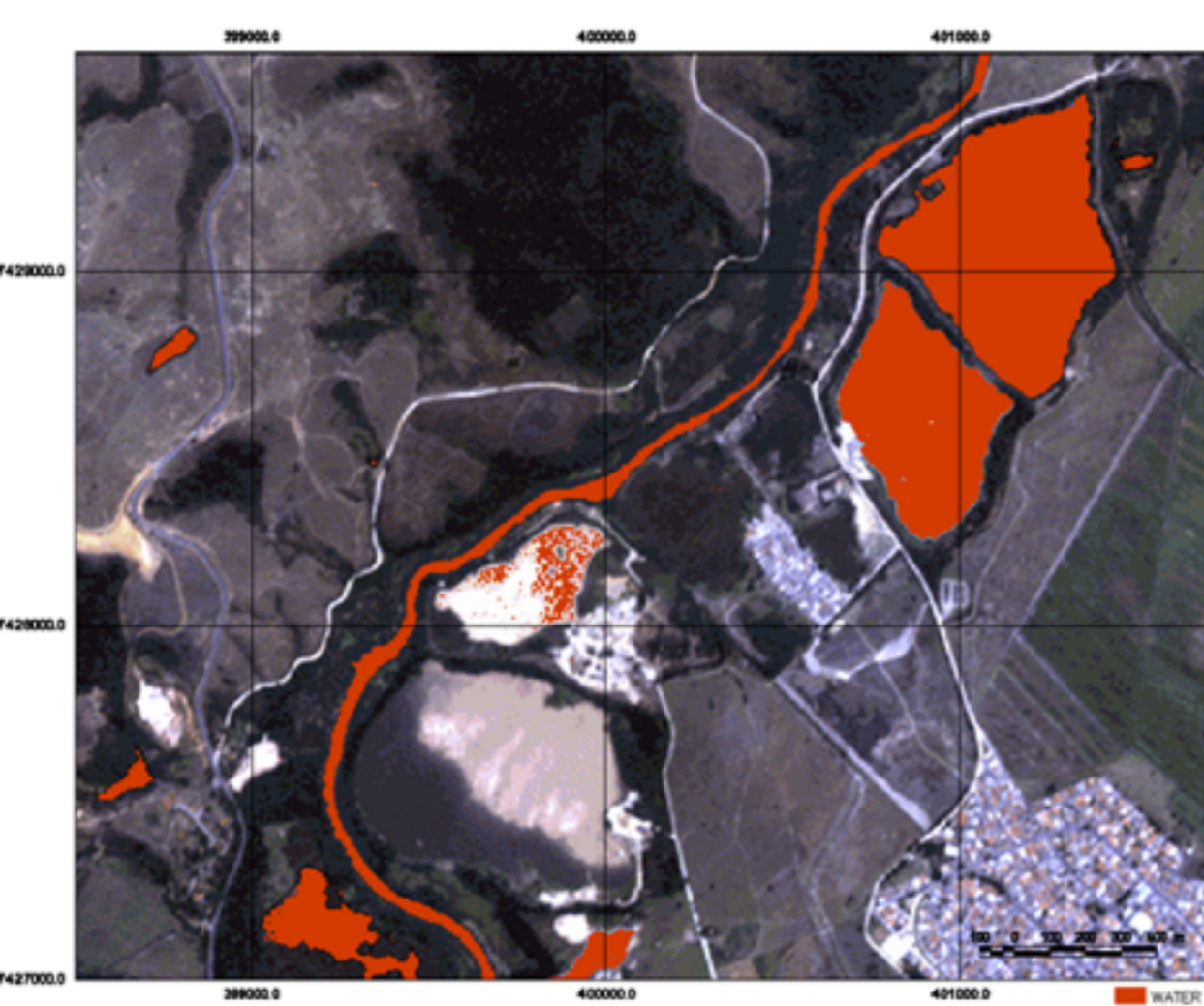
**WATER** - 90 percentile for water pixels

**WATER95** - 95 percentile for water pixels,

**WATER90** - 98 percentile for water pixels

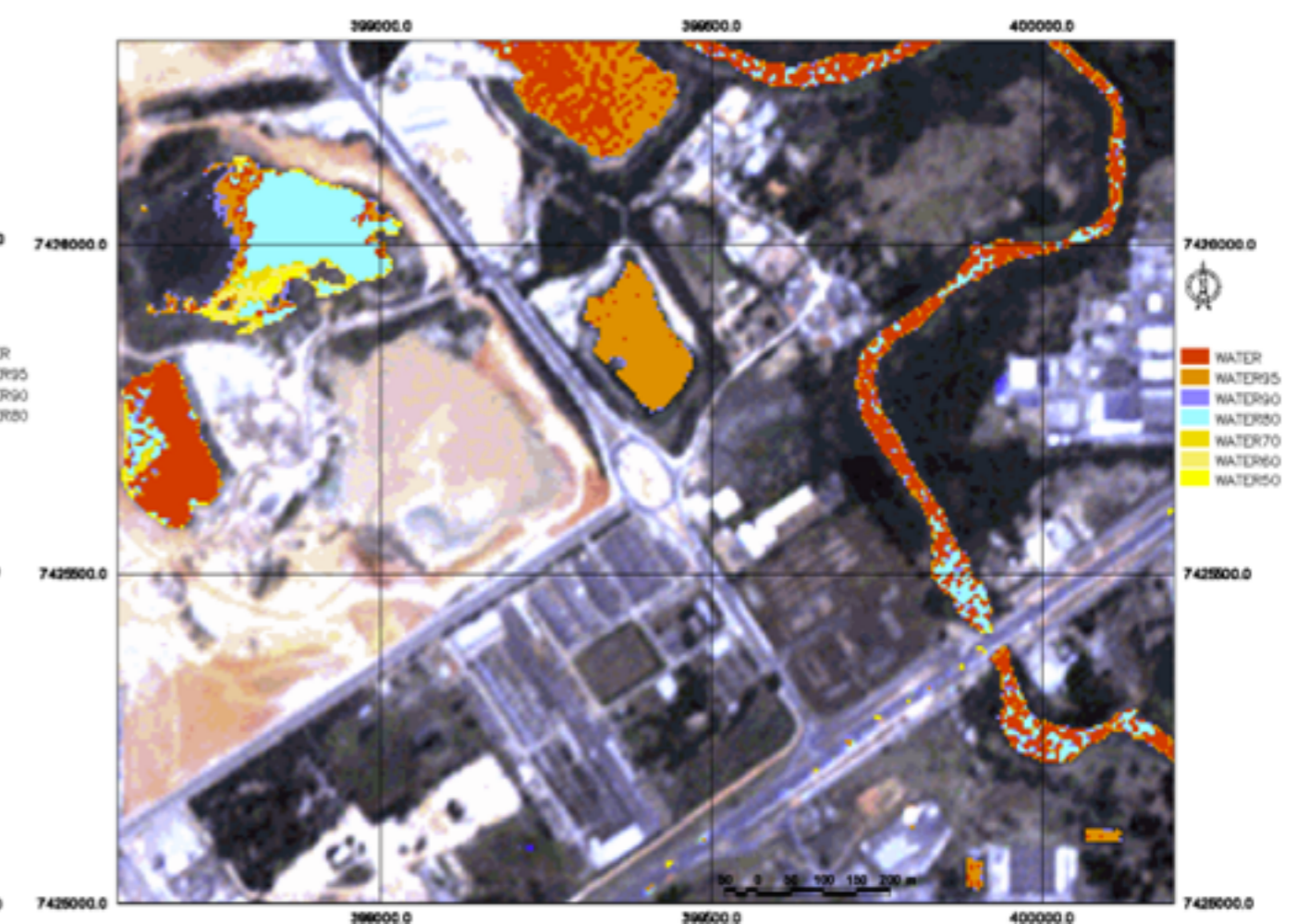
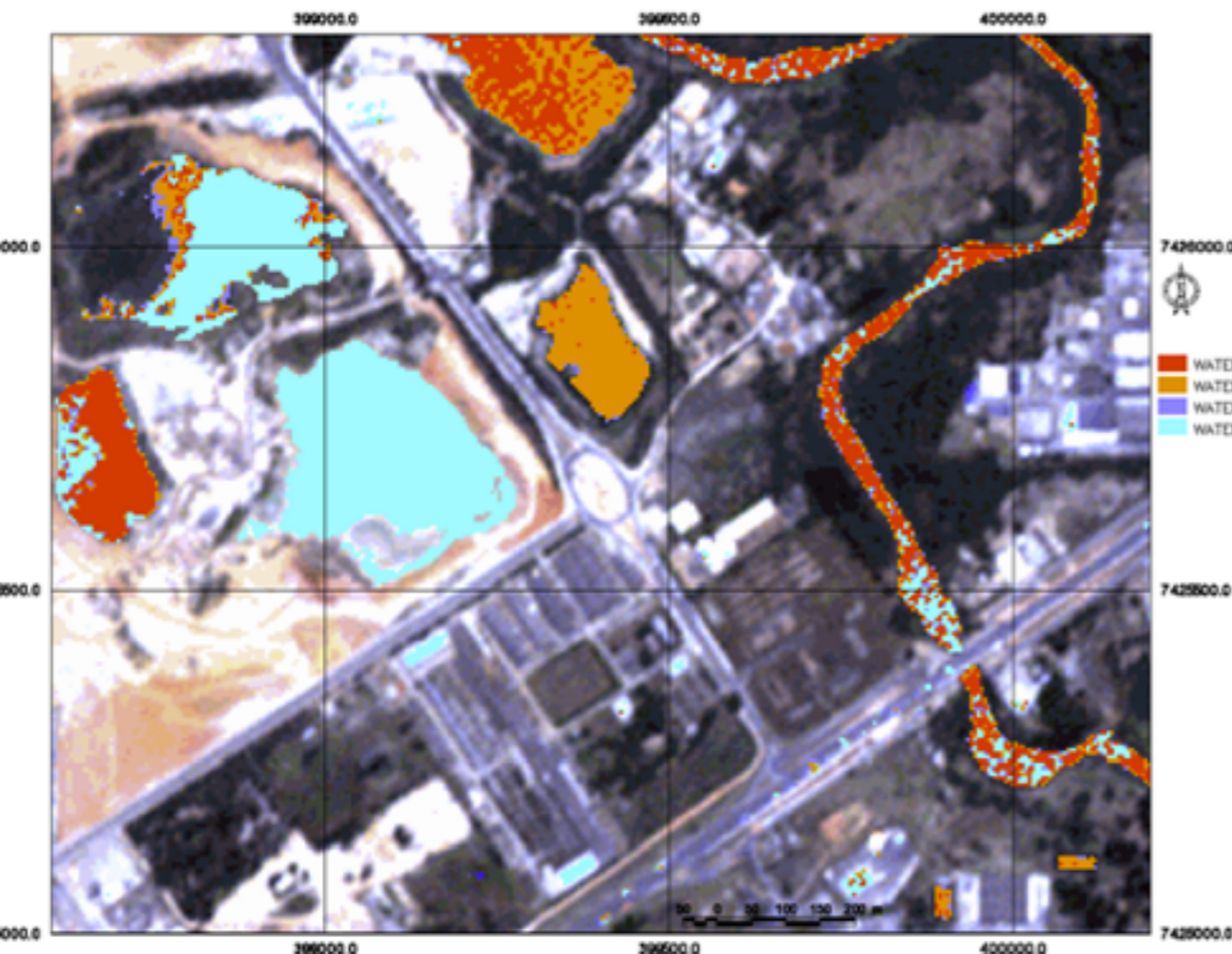
**WATER80** - *non-water* 98 percentile: 2% of non-water values

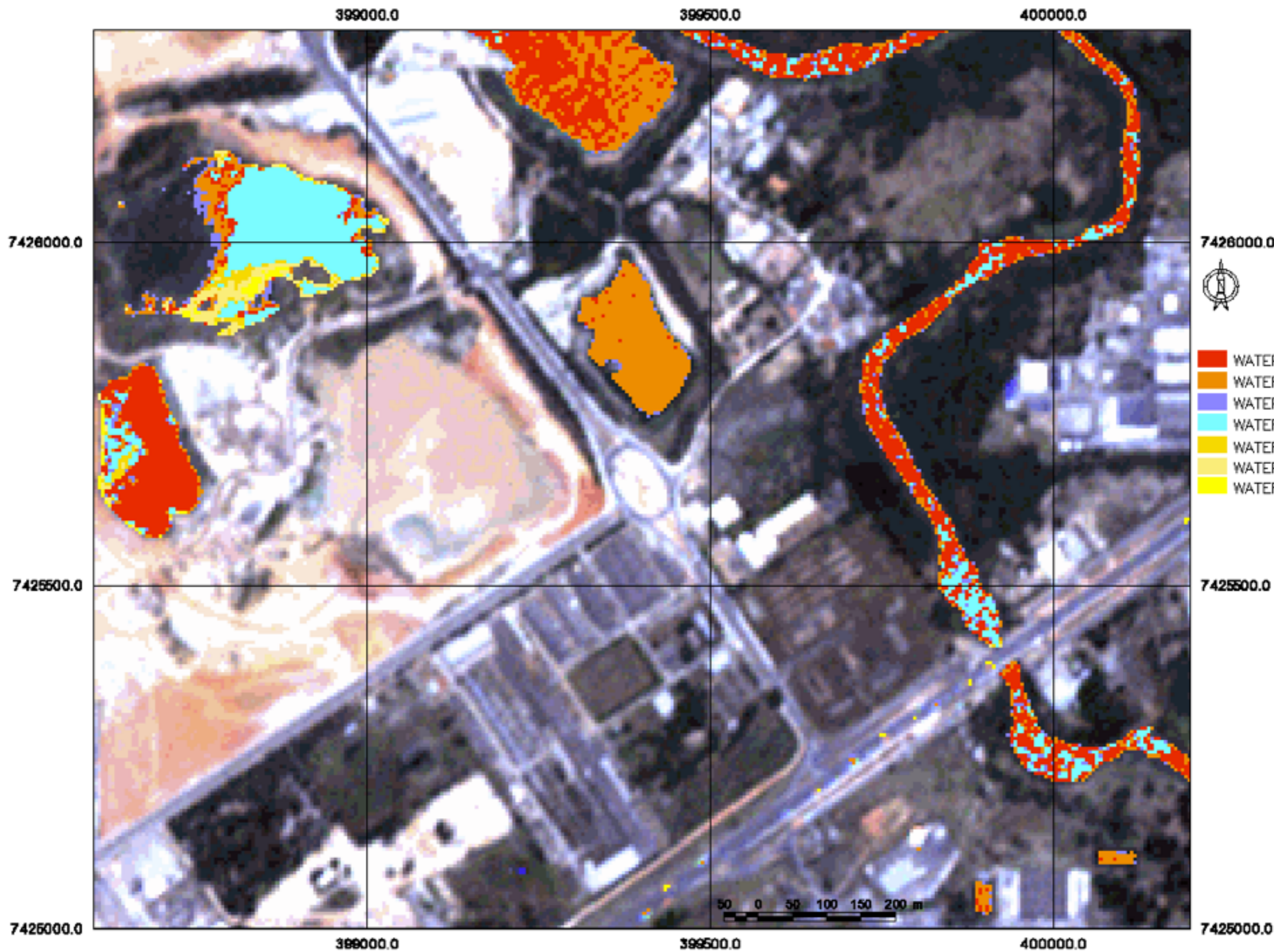
```
slc2 = Atribua ( CategoriaFim = "Agua" )
{
  "WATER" : (hue >= 0 && hue < 15), //W90% 0-15
  "WATER95" : (hue >= 15 && hue < 16) || //W95% 323-16
              (hue >= 323 && hue <= 360),
  "WATER90" : (hue >= 16 && hue < 17) || //W98% 249-17
              (hue >= 249 && hue < 323),
  "WATER80" : (hue >= 17 && hue < 205) //NW98% 309-205
};
```



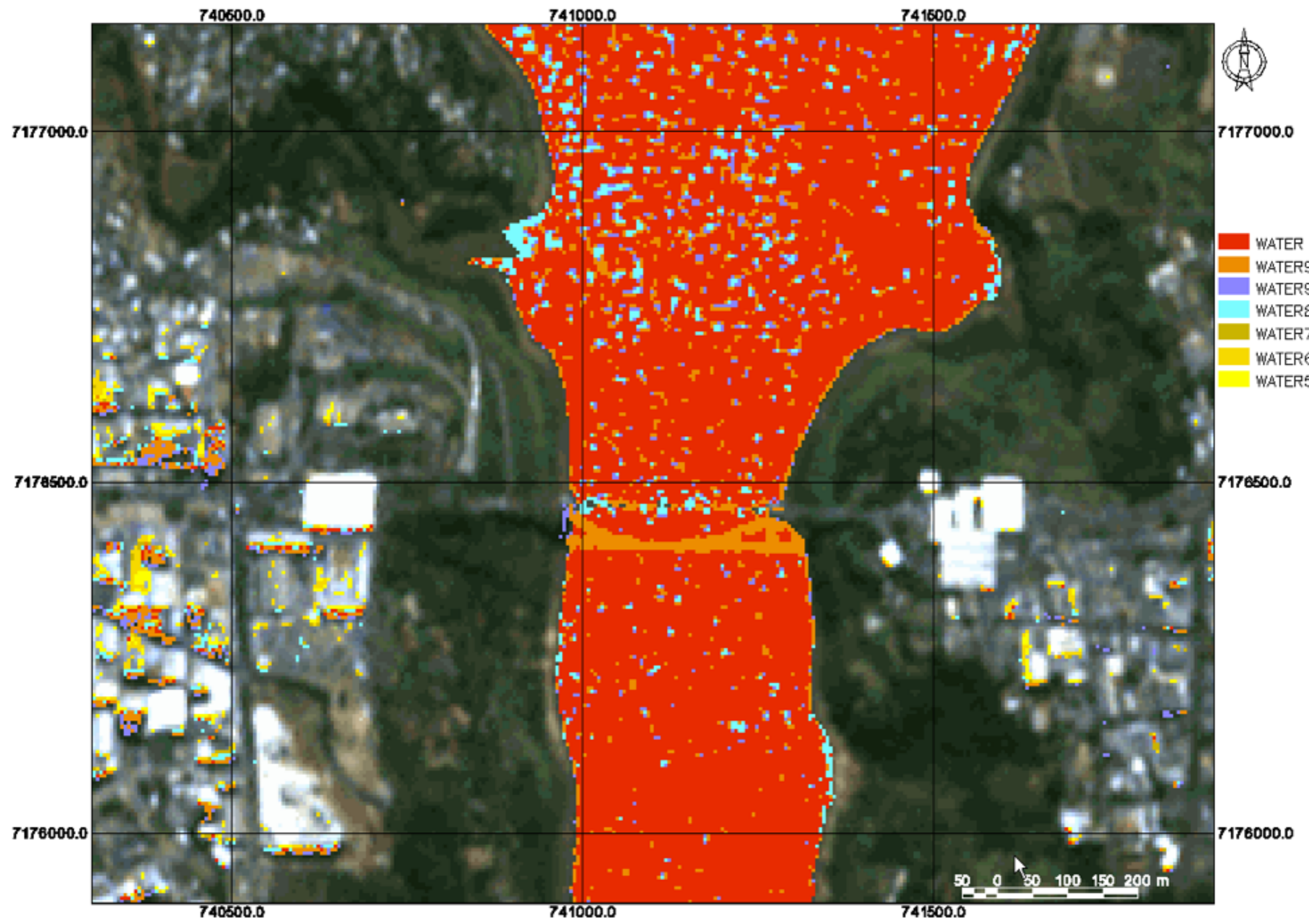
# Method - Hue from R2G3B5

	WATER	WATER95	WATER90	WATER80	WATER70	WATER60	WATER50
Hue	16° - 35°	35° - 36° / 324° - 16°	36° - 37° / 308° - 324°	37° - 160°	37° - 160°	37° - 160°	37° - 160°
MNR (Min from all 5 bands)	0 - 0.475	0 - 0.475	0 - 0.475	0 - 0.320	0.320 - 0.335	0.335 - 0.375	0.375 - 0.475



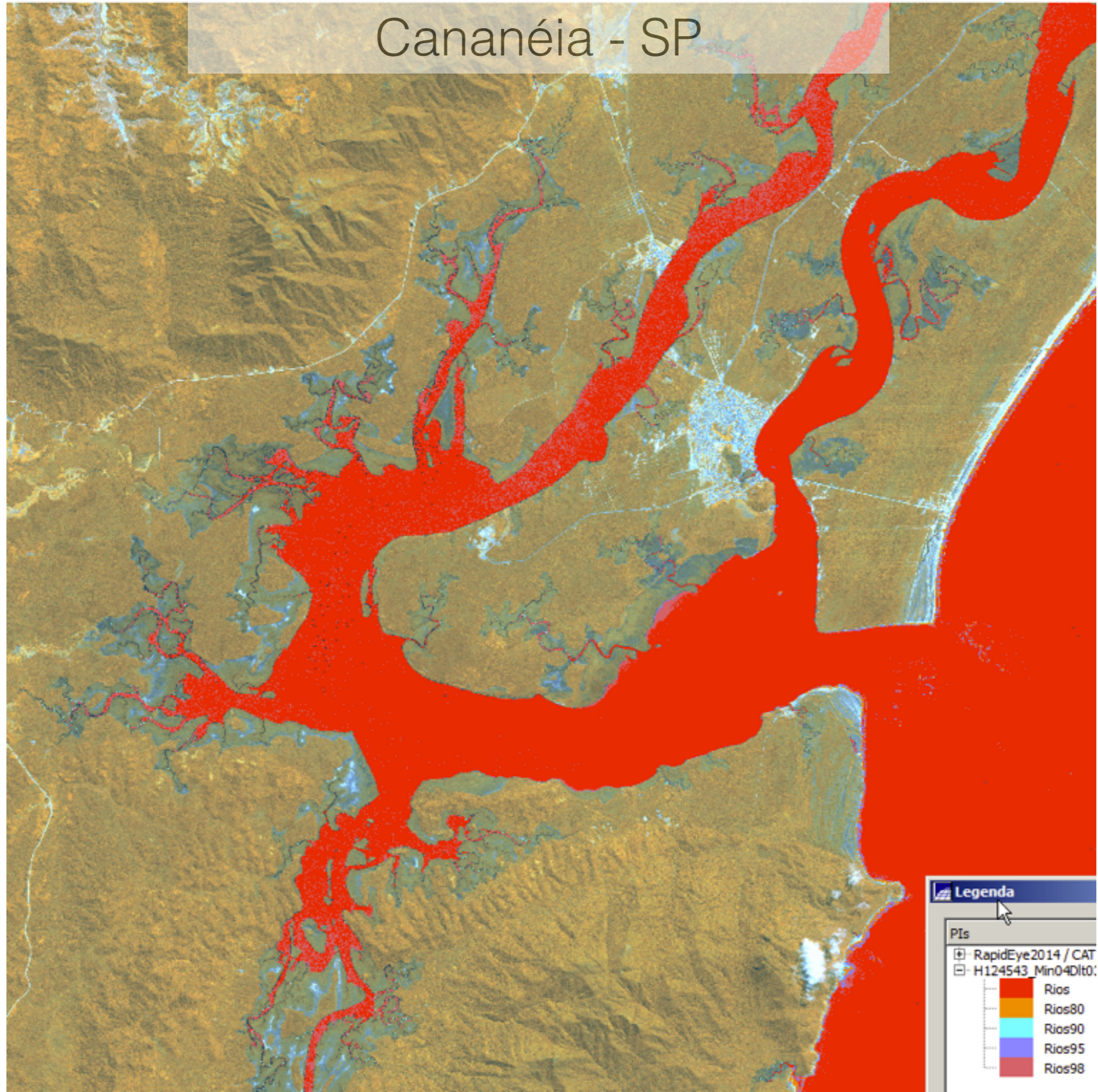






# Examples






# Cananéia - SP



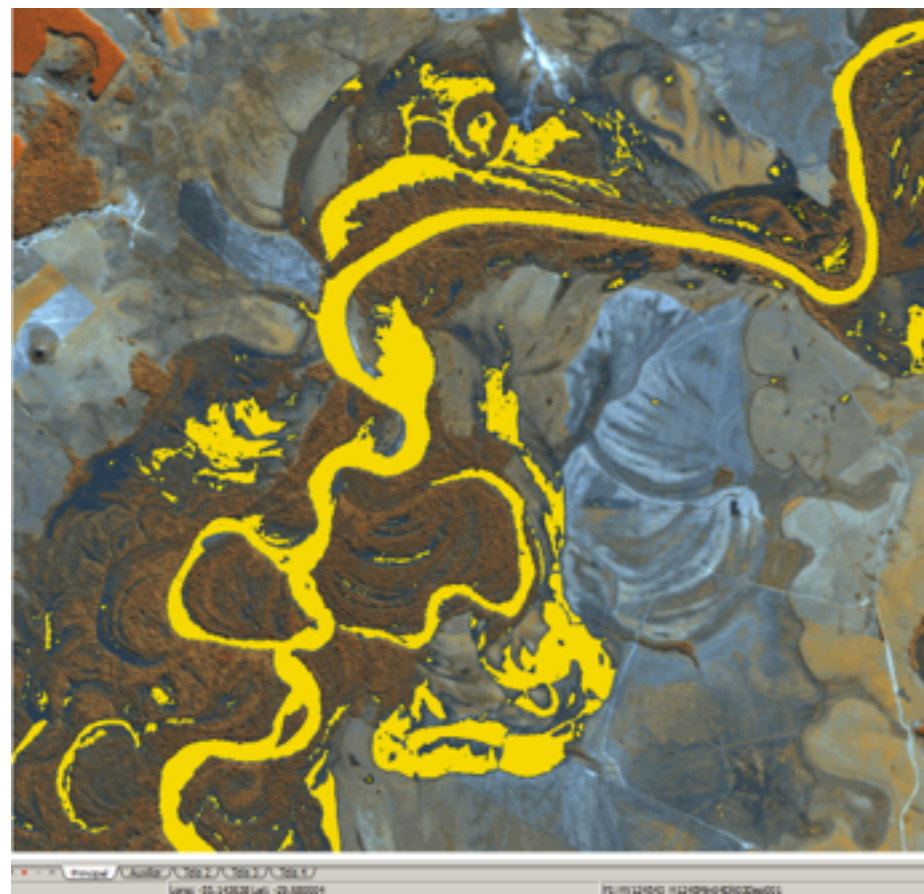
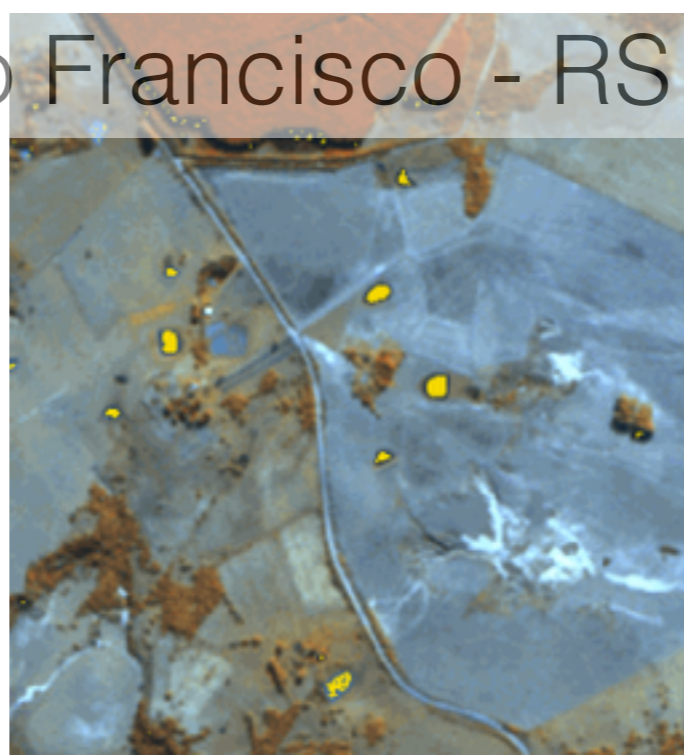
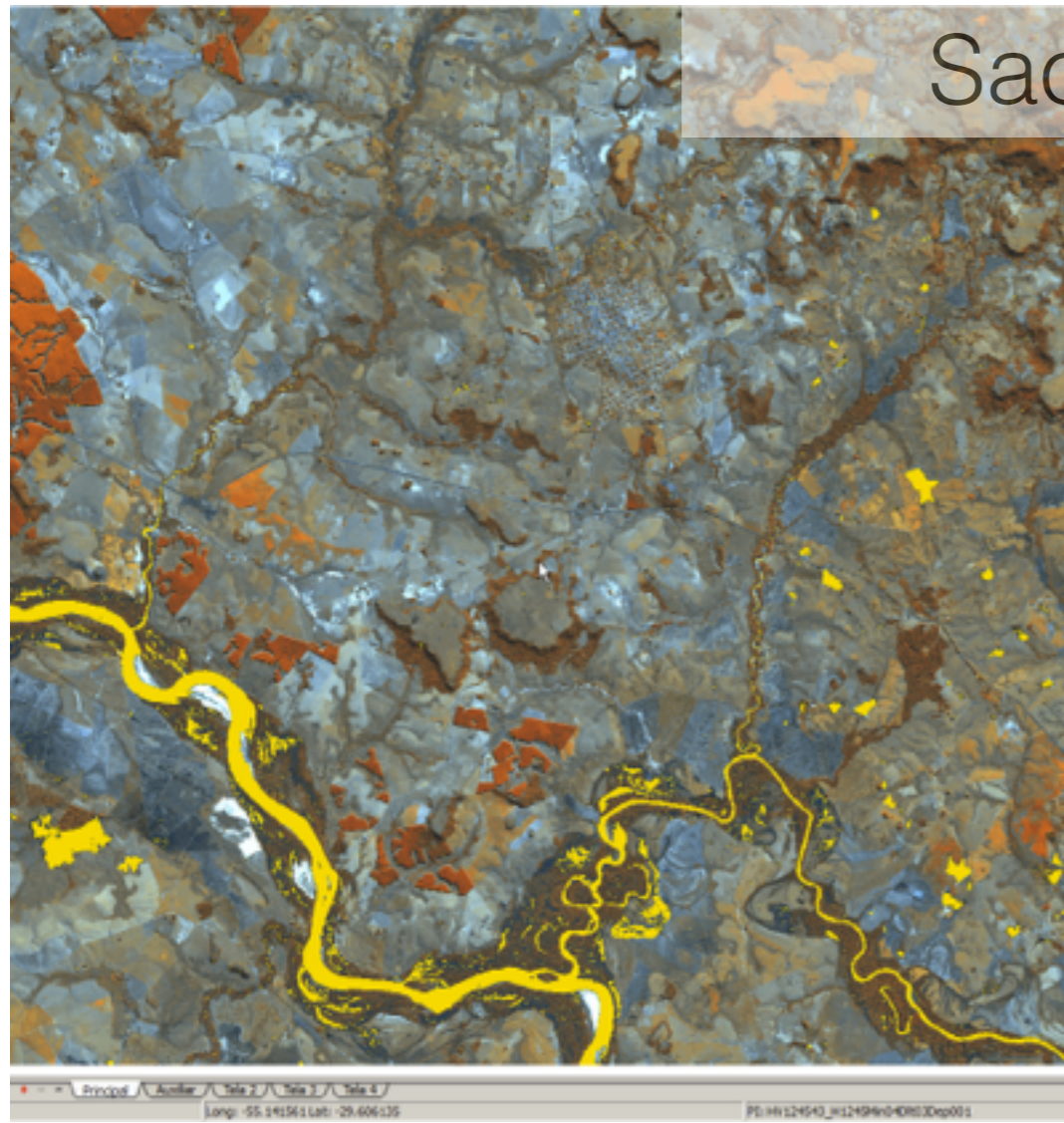
**Legenda**

PIs

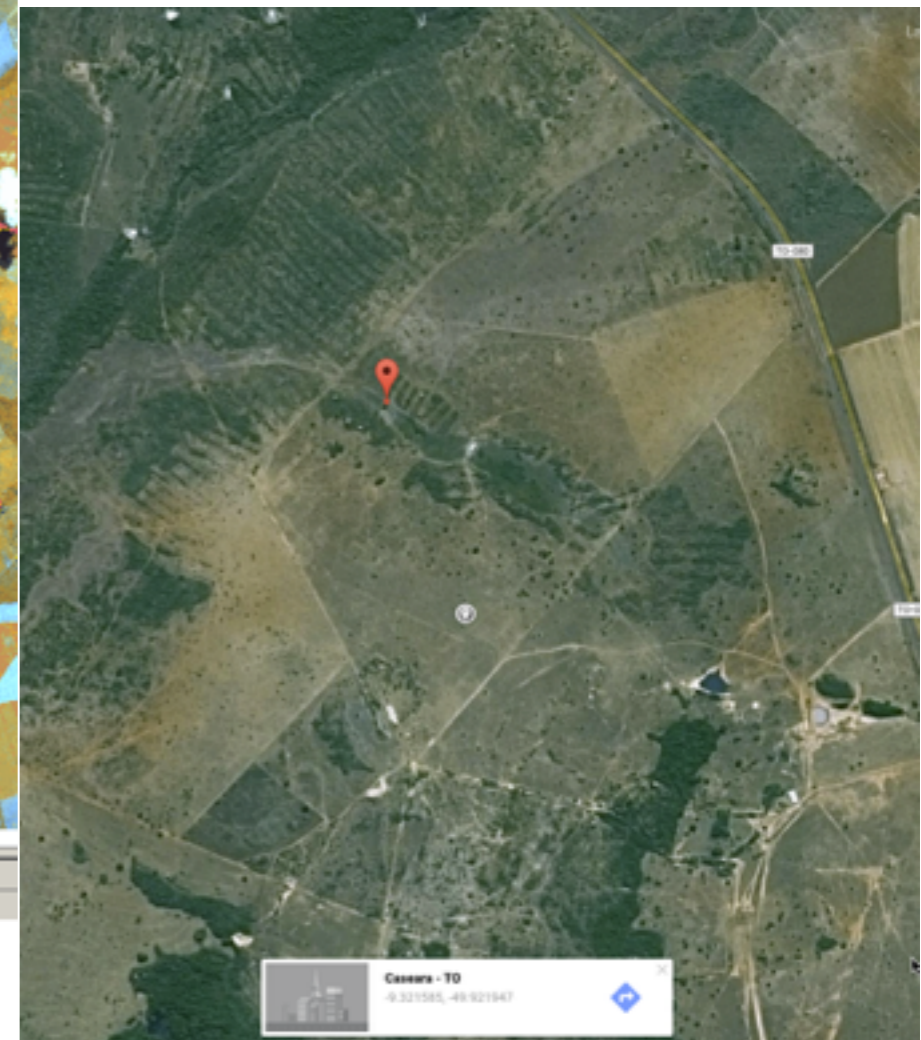
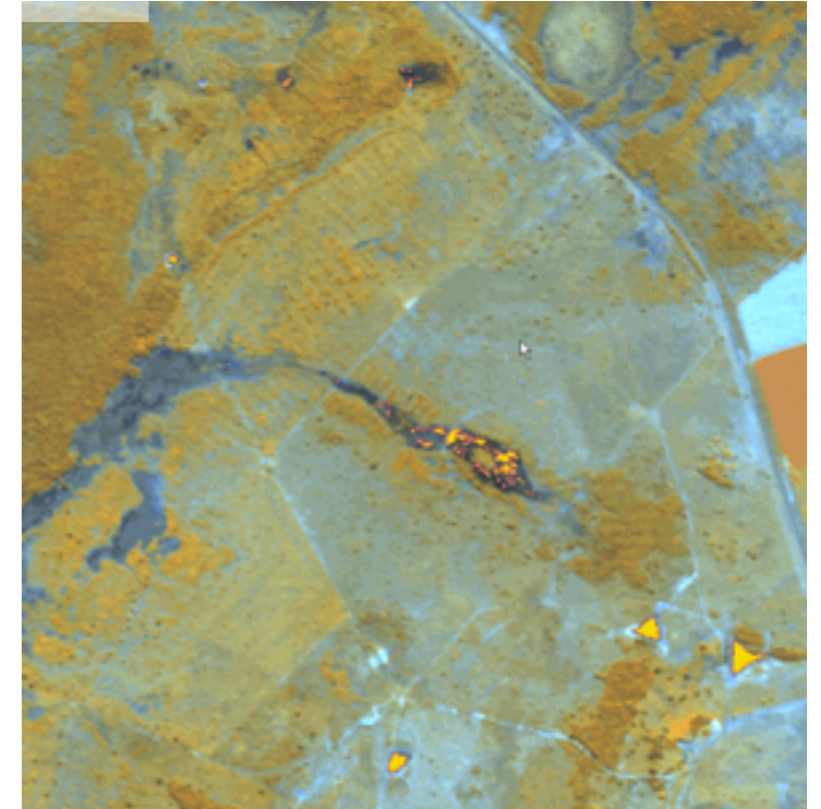
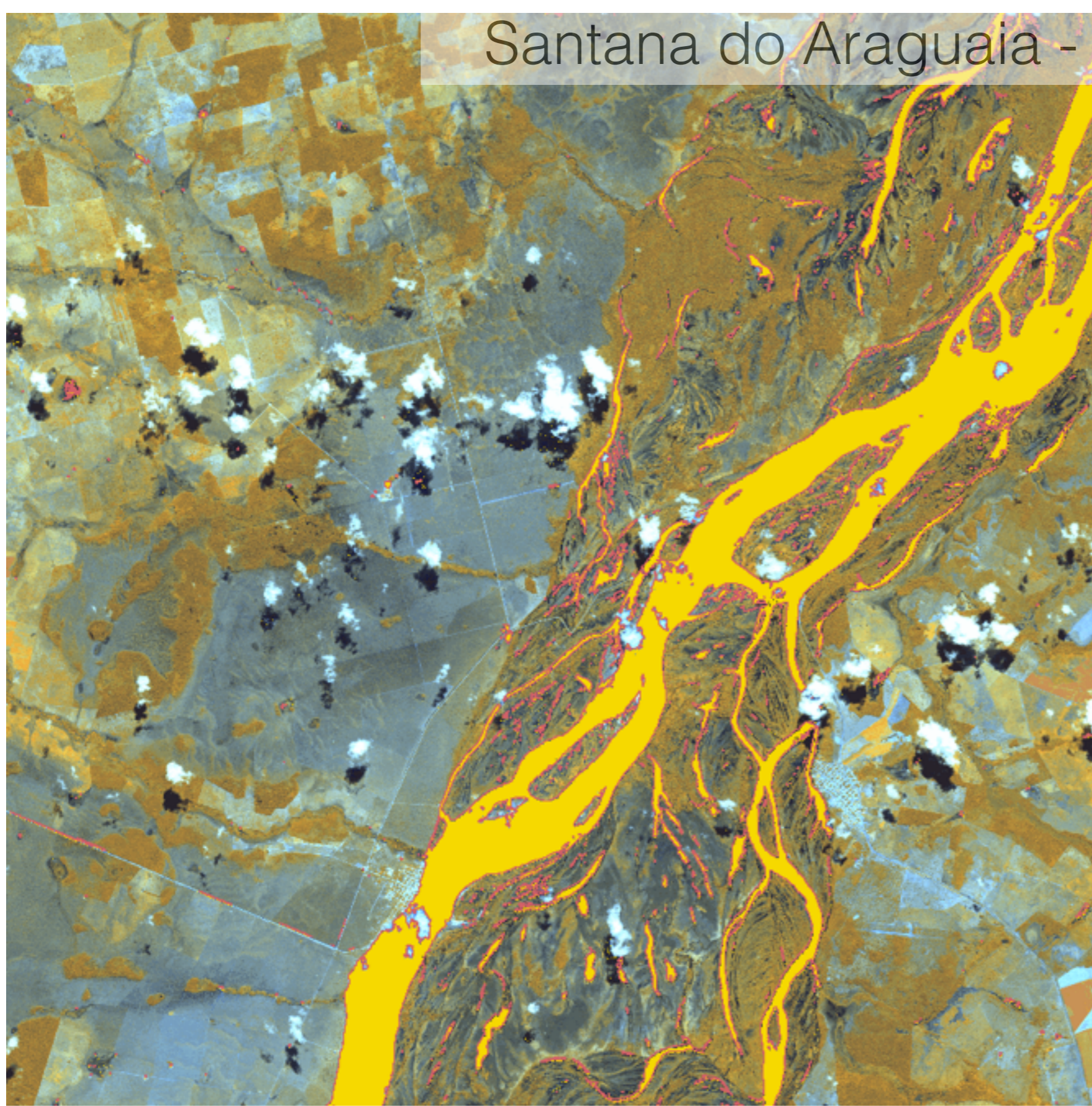
- RapidEye2014 / CAT
- H124543 Min04Dlt0:

	Rios
	Rios80
	Rios90
	Rios95
	Rios98

# Sao Francisco - RS



# Santana do Araguaia - PA

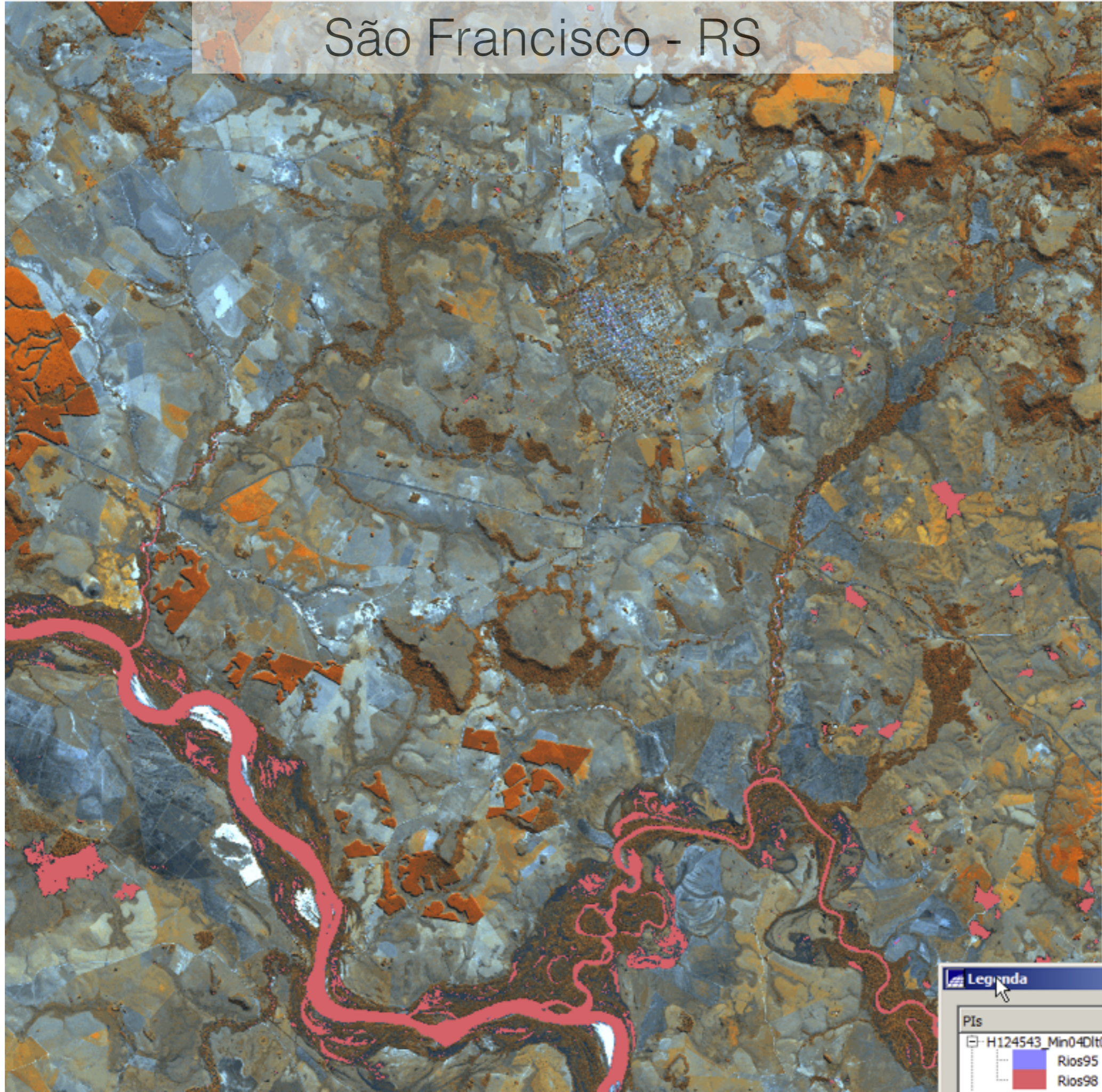


Principal Auxiliar Tela 2 Tela 3 Tela 4

PI: HV124543\_H1245H543250Min04Dlt03Dep001

Censos - TO  
9.321585, -49.921947

# São Francisco - RS



**Legenda**

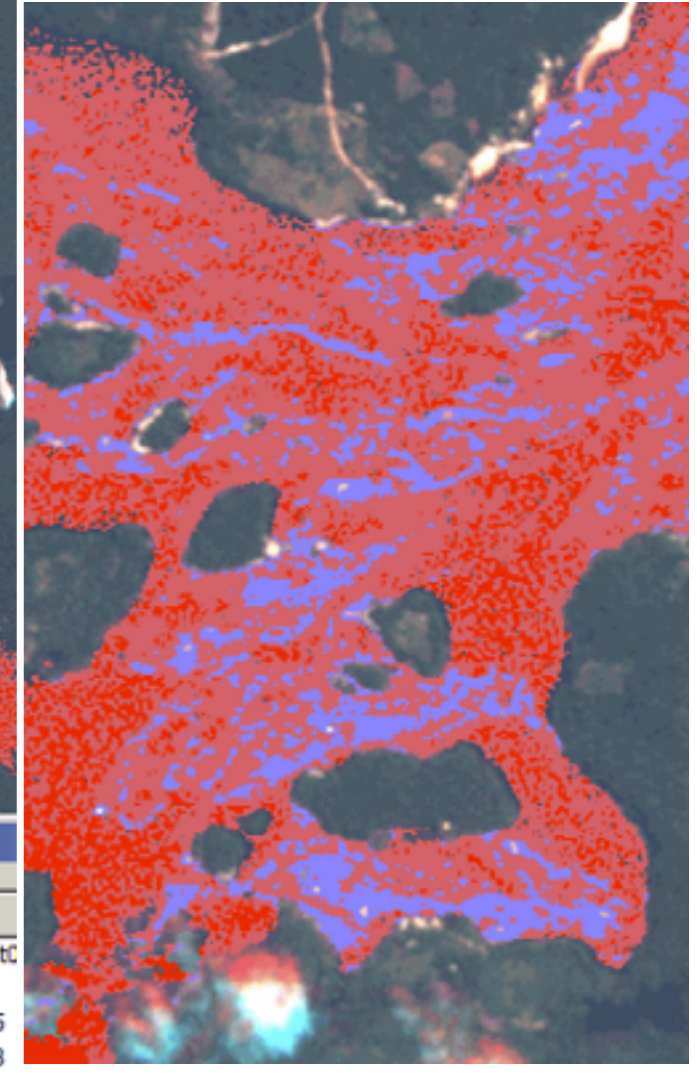
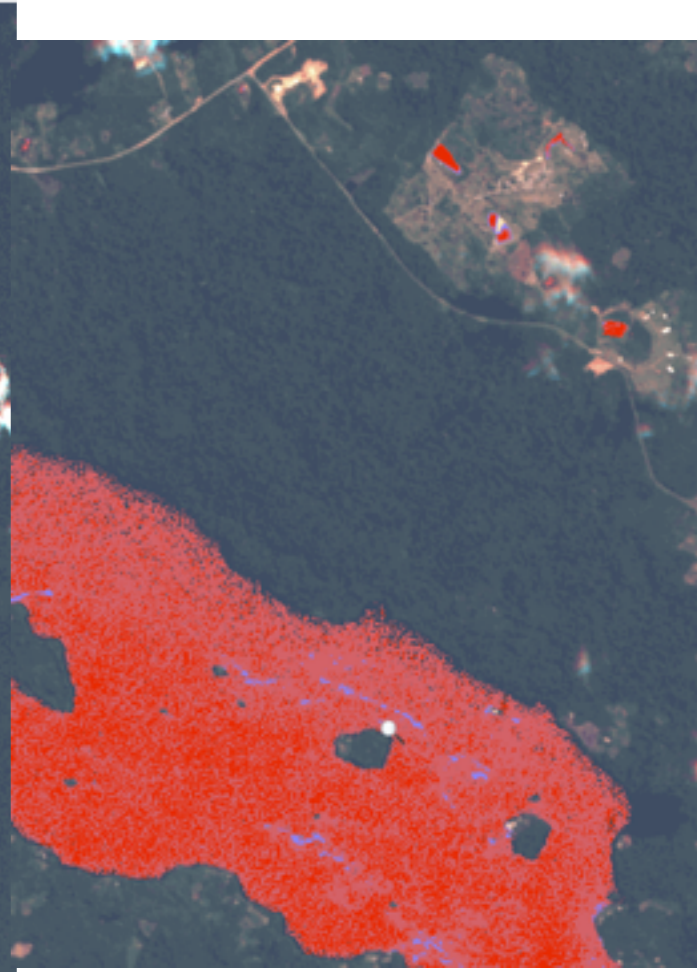
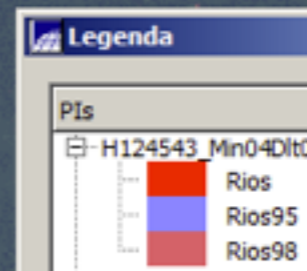
Pis

H124543\_Min04Dlt0

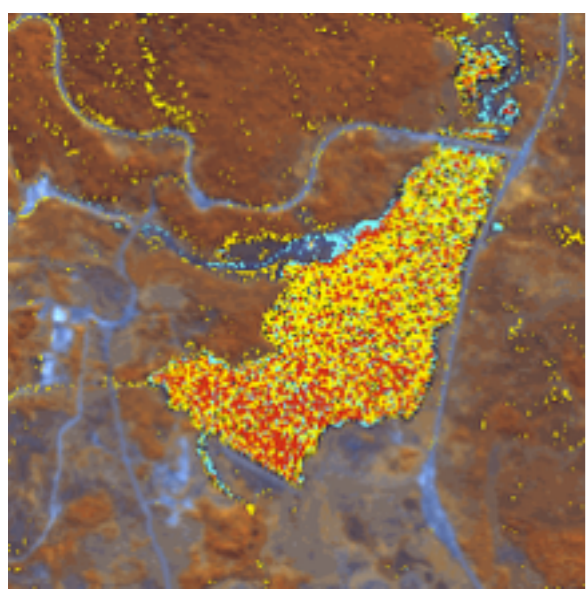
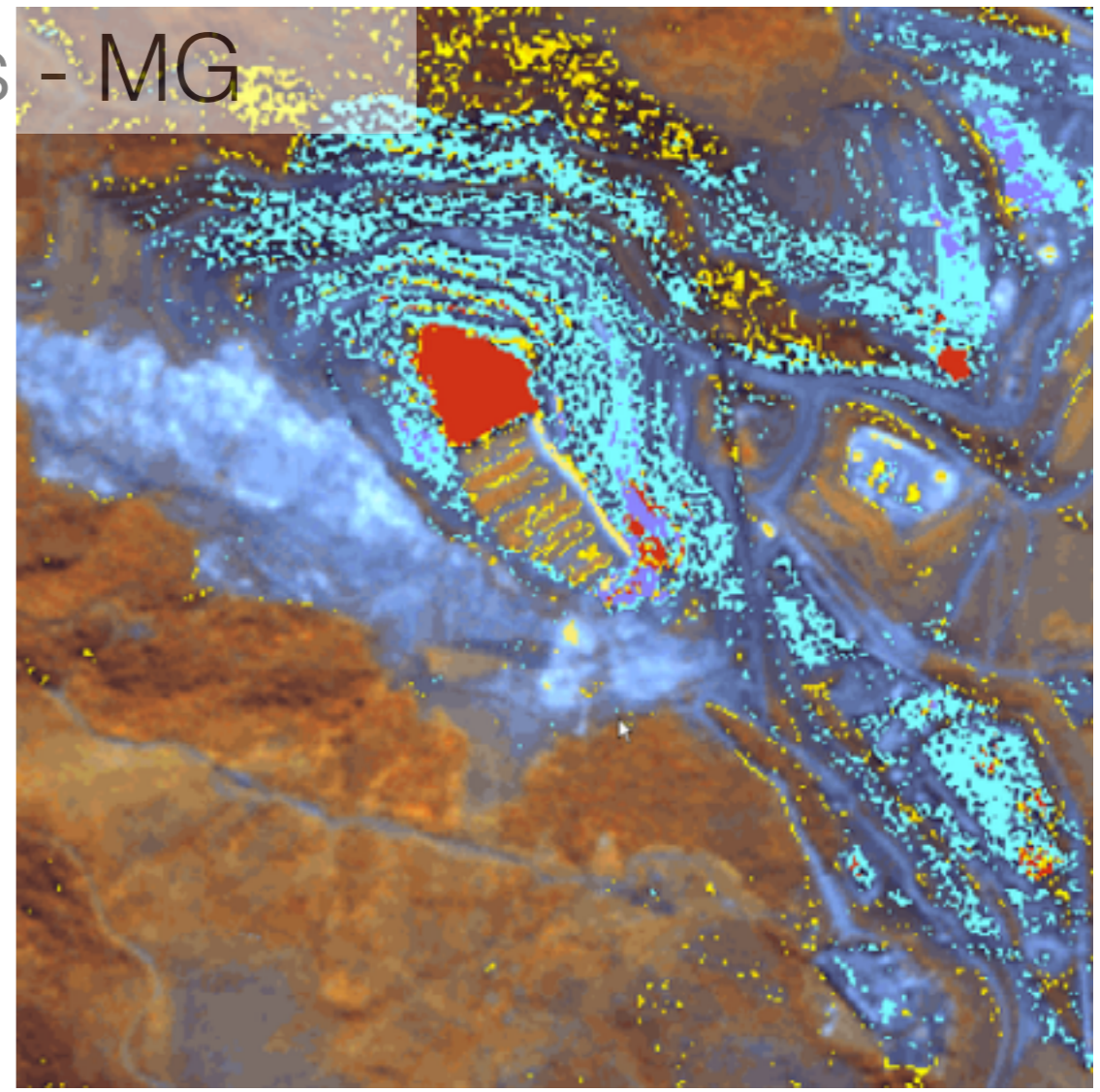
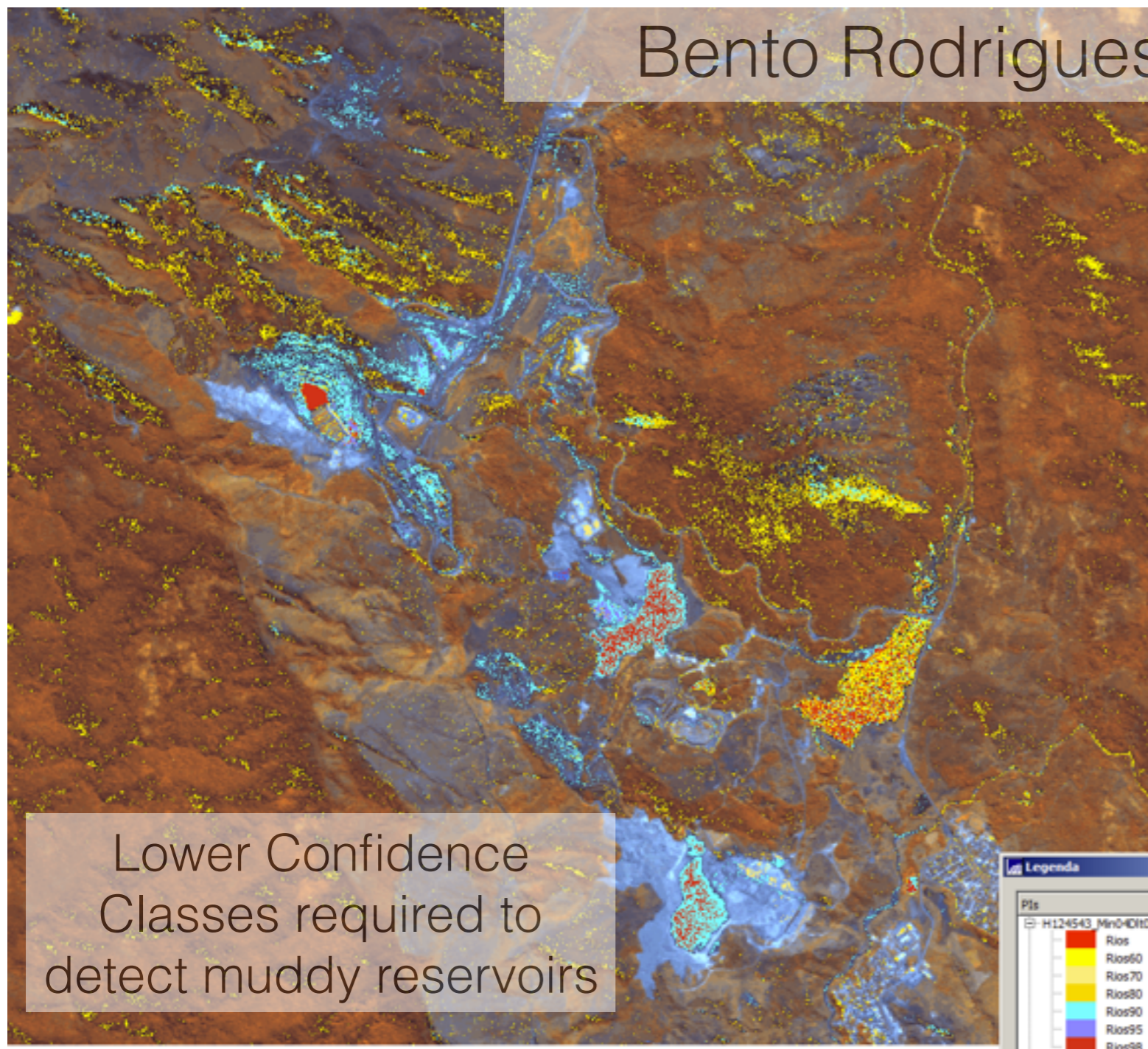
- Rios95
- Rios98

# Sao Gabriel - AM

Sun Glint and Foam near Rapids

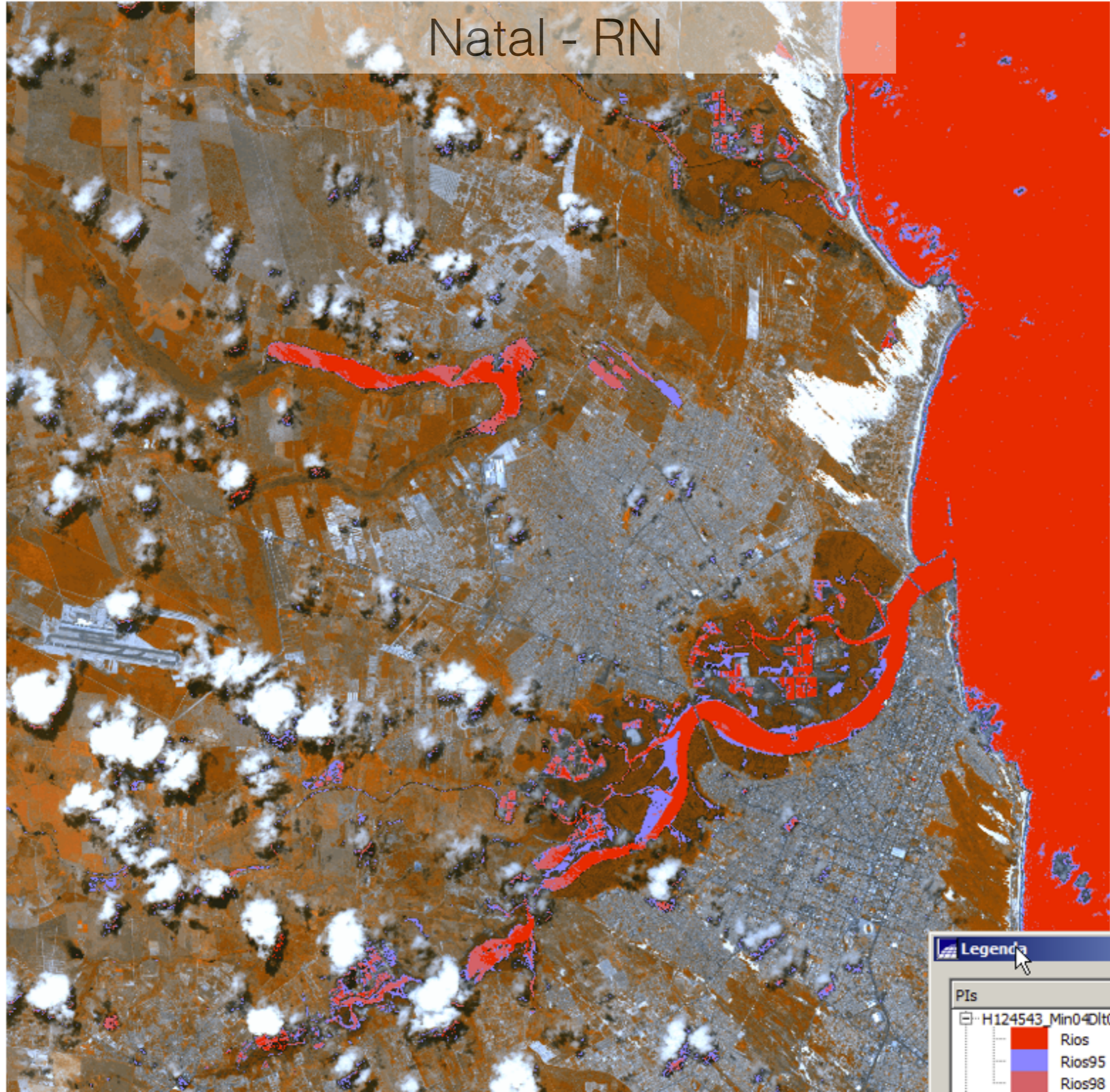


# Bento Rodrigues - MG

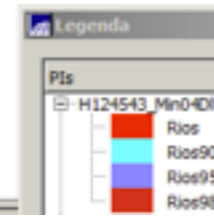
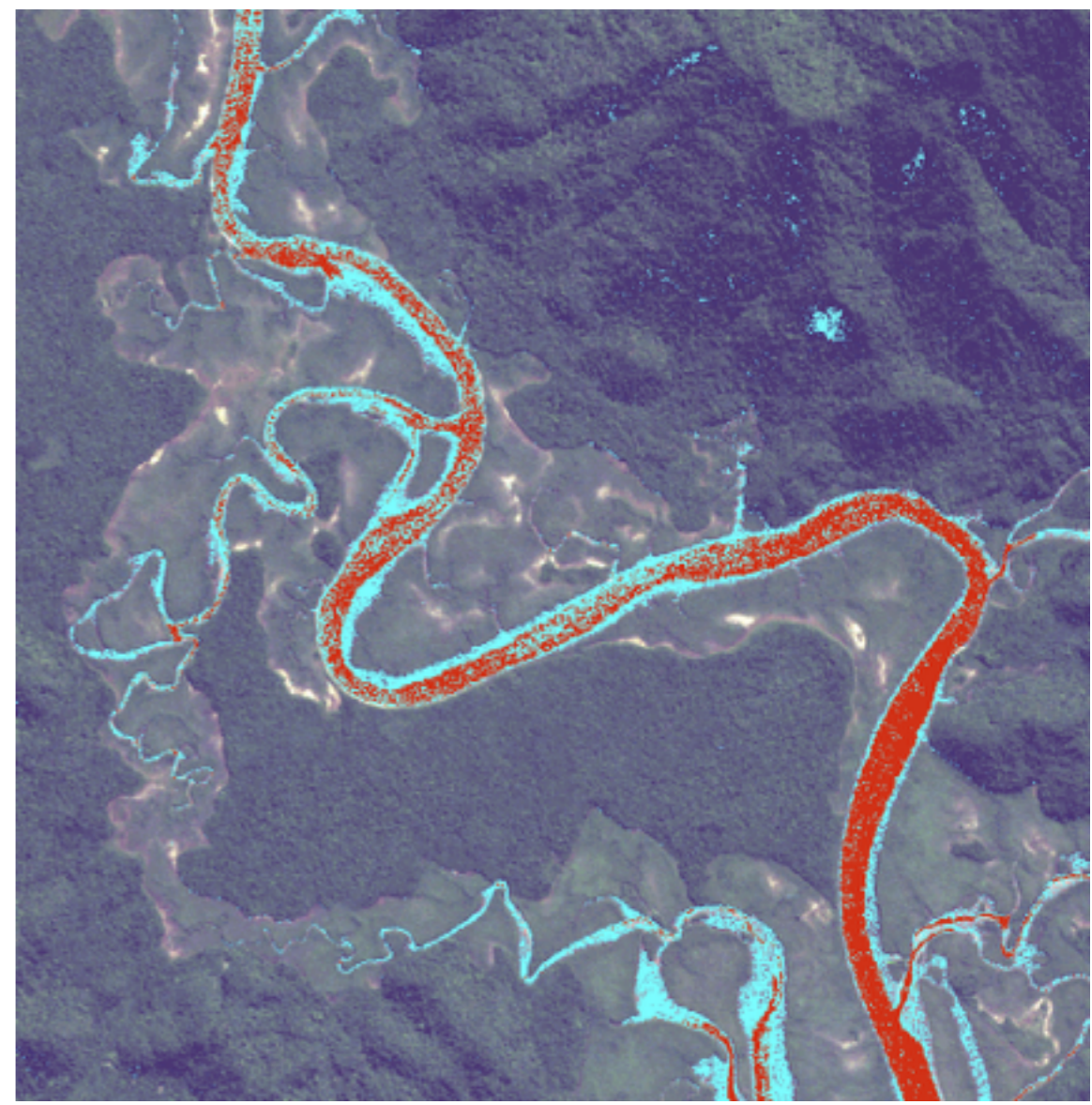
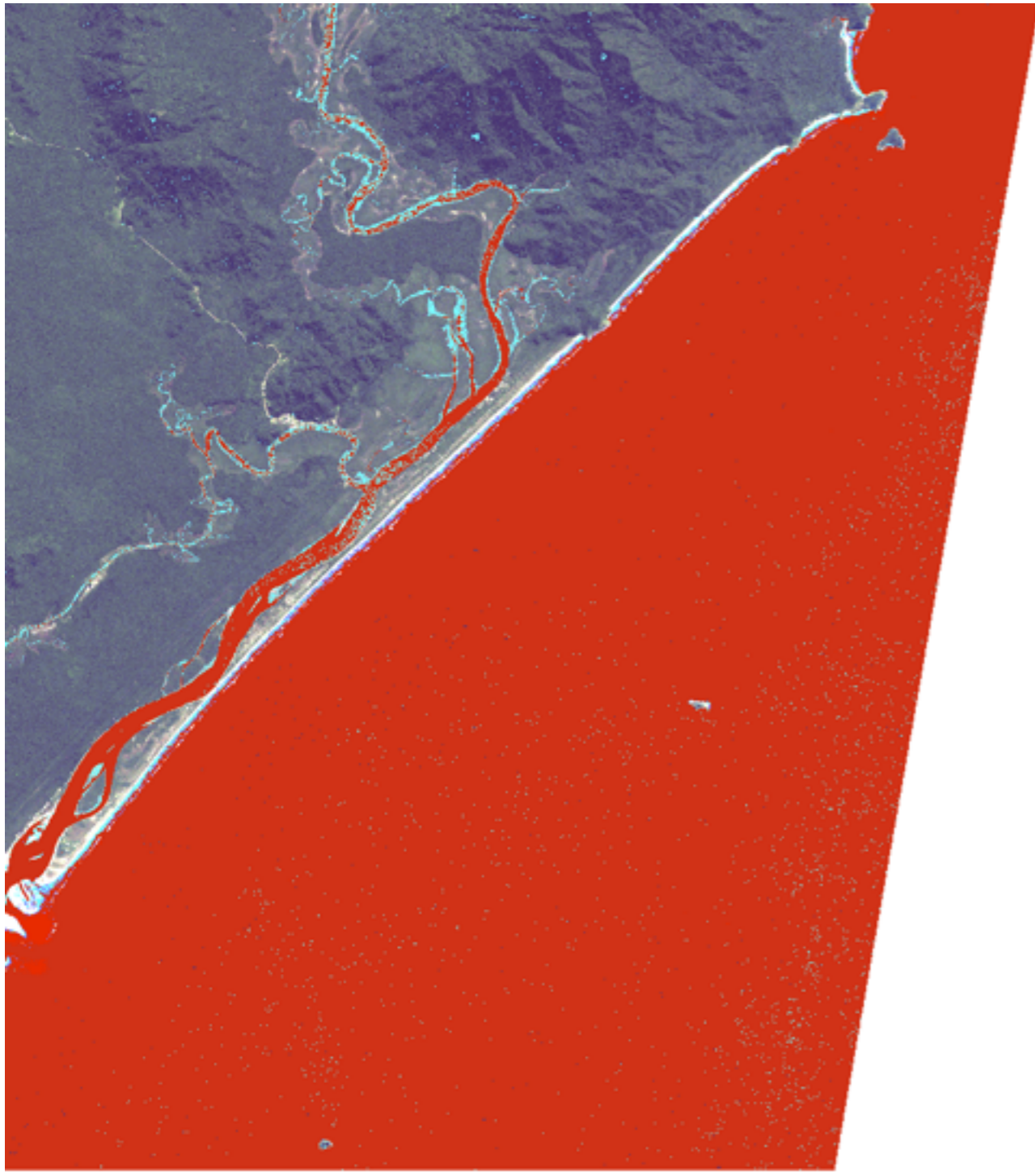




# Natal - RN

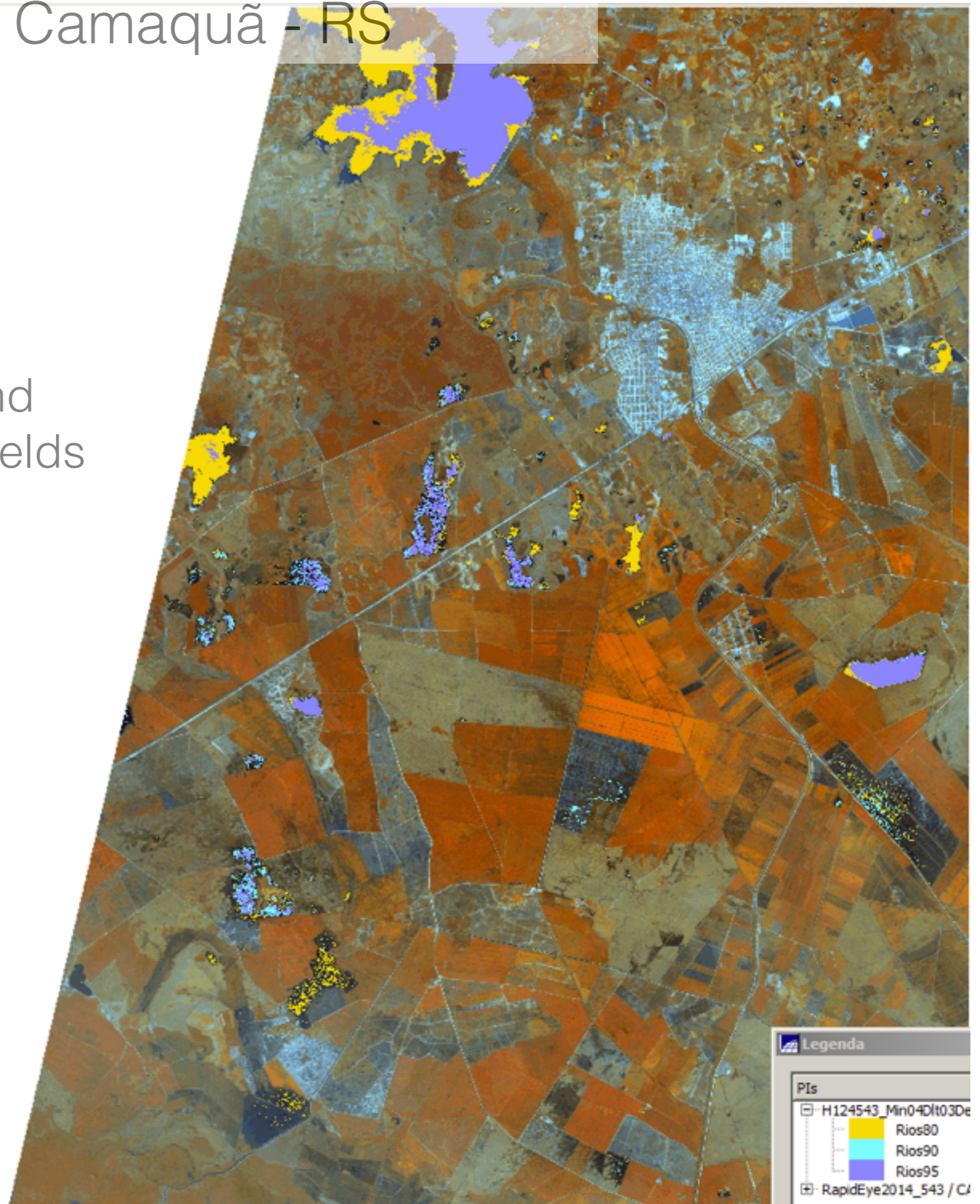


# Ariri - SP

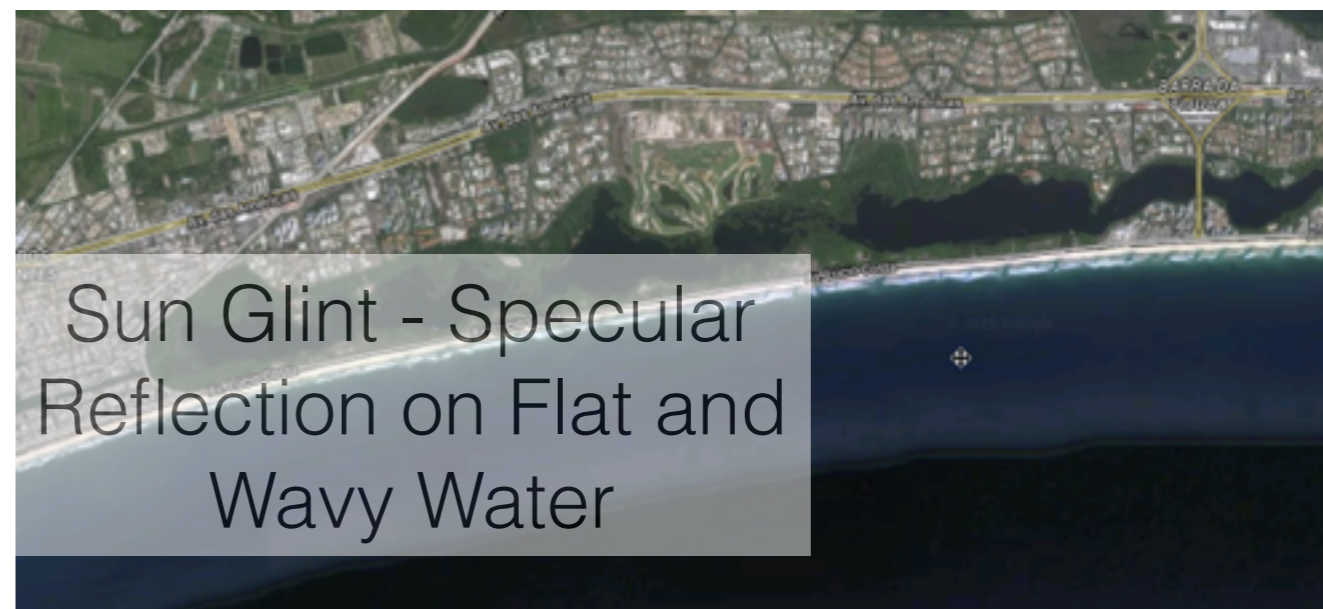
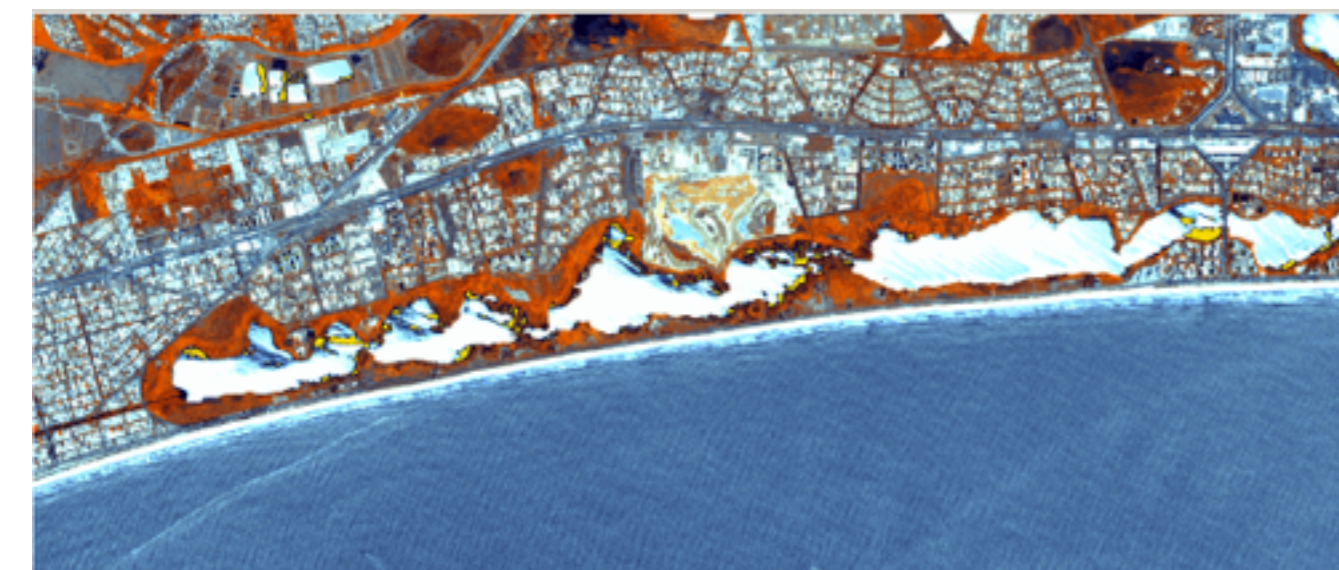
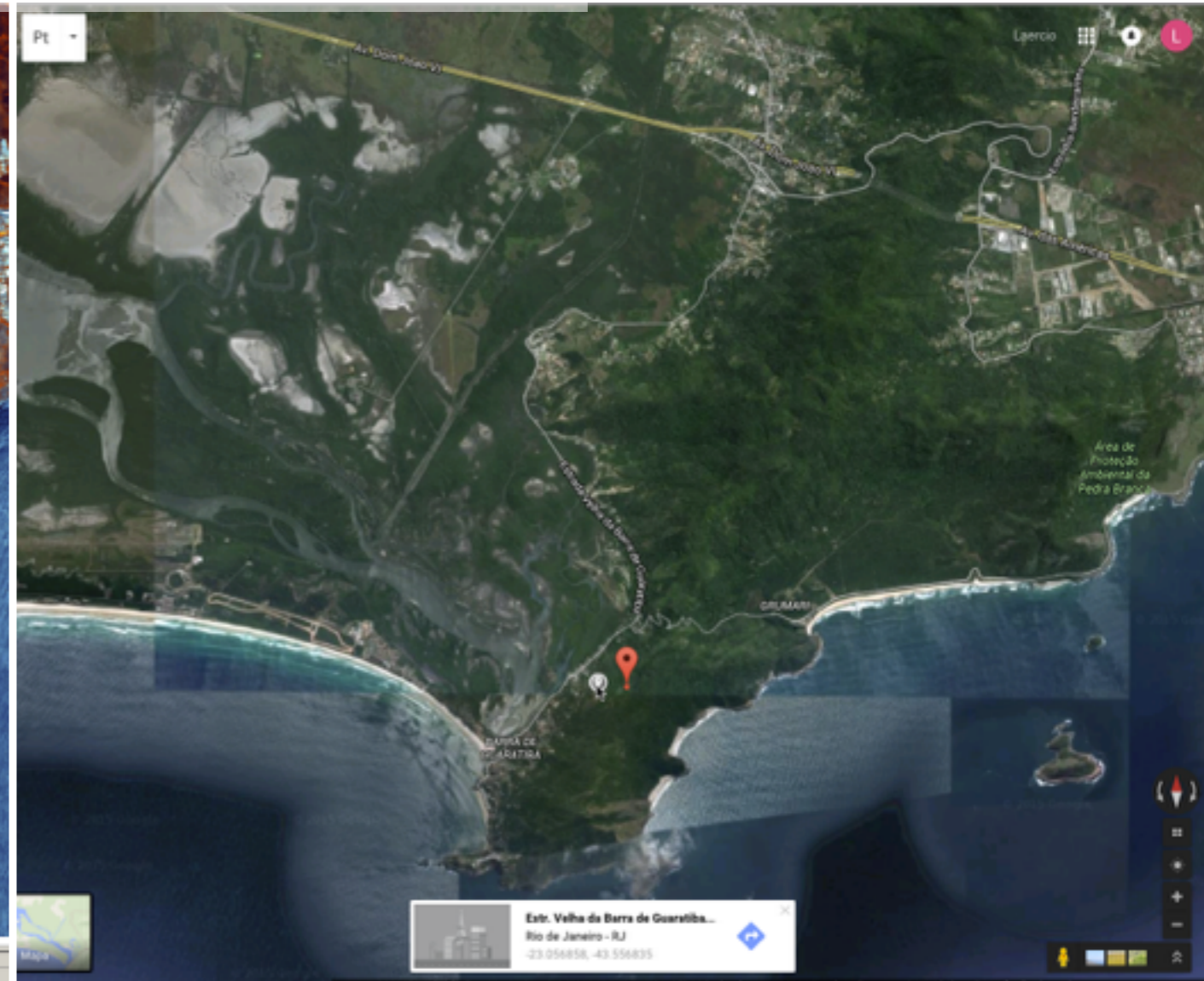
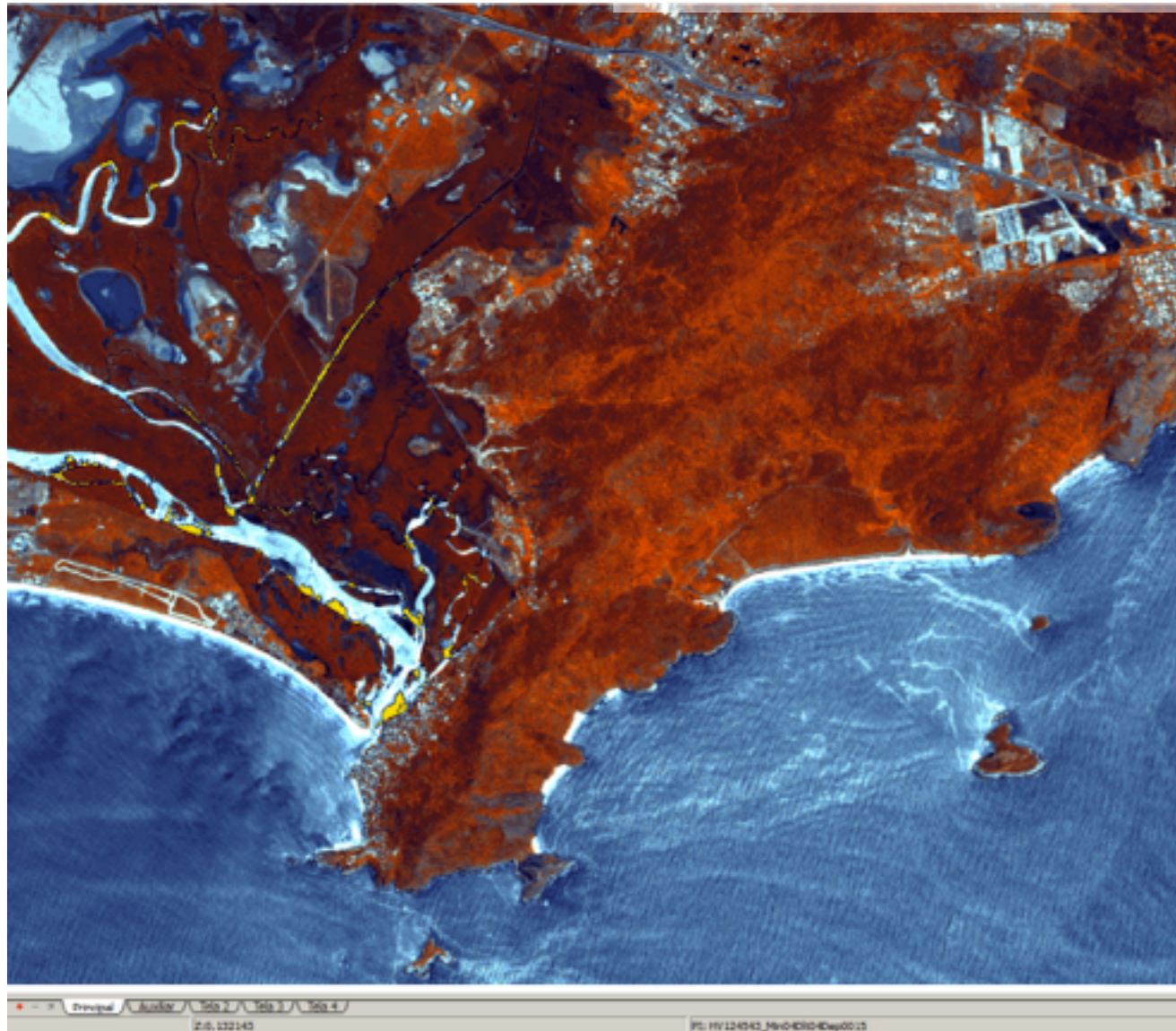


# Camaquã - RS

Reservoirs and  
Flooded Rice Fields



# Barra - RJ



Sun Glint - Specular Reflection on Flat and Wavy Water





# Santana do Araguaia - PA

Noise - Shadows

Legenda

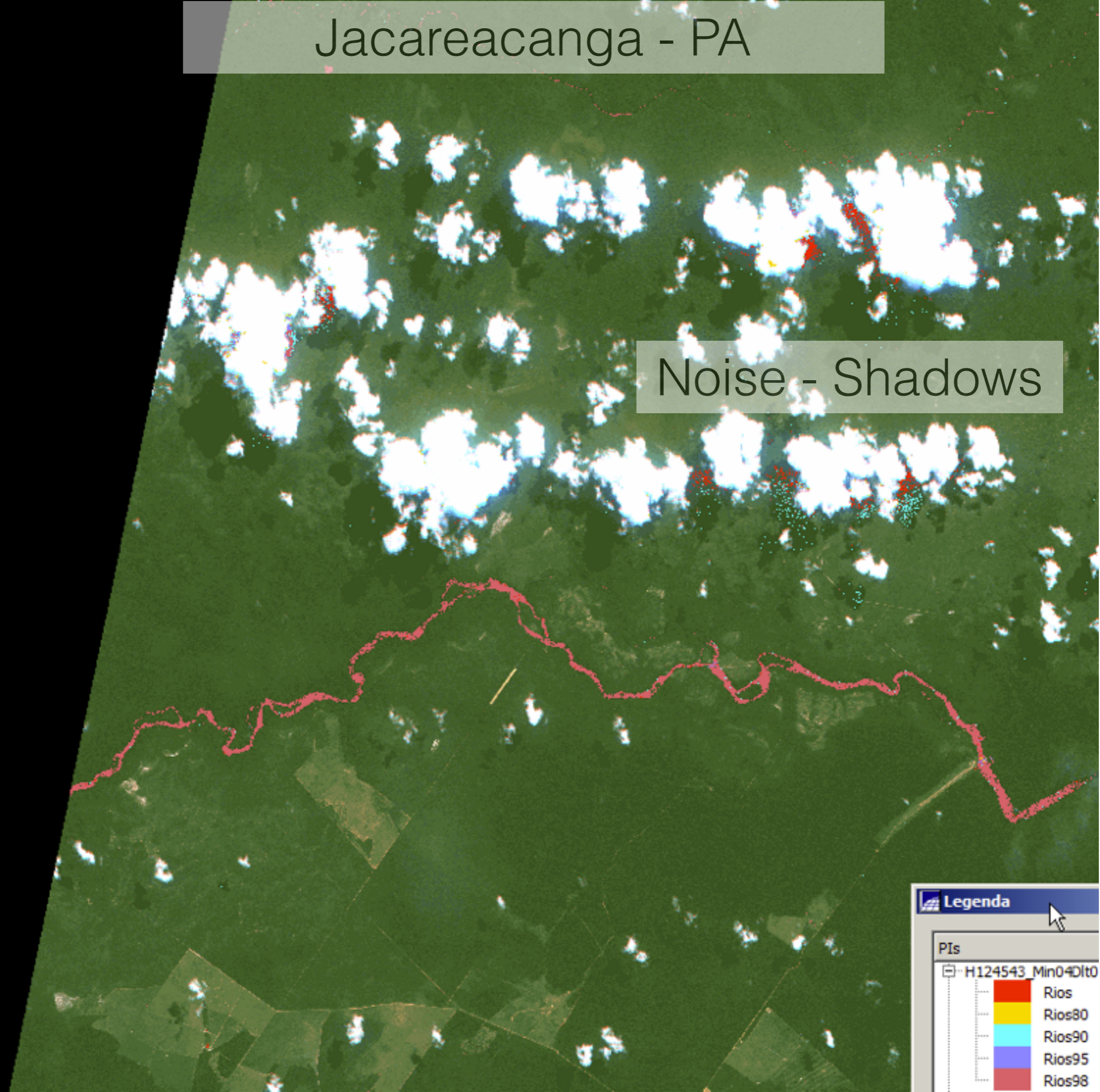
PIs

H124543\_Min04Dlt03Dep001Class / Aguas

	Rios
	Rios90
	Rios95
	Rios98

# Jacareacanga - PA






Noise - Shadows



**Legenda**

PIs

H124543\_Min04Dlt0

	Rios
	Rios80
	Rios90
	Rios95
	Rios98

# Produto

1 Cobertura RapidEye: 2014 - mais recente

~18000 cenas, 5000x5000, 5 metros

Código em TerraLib5, executando na chronos

GeoTIFF

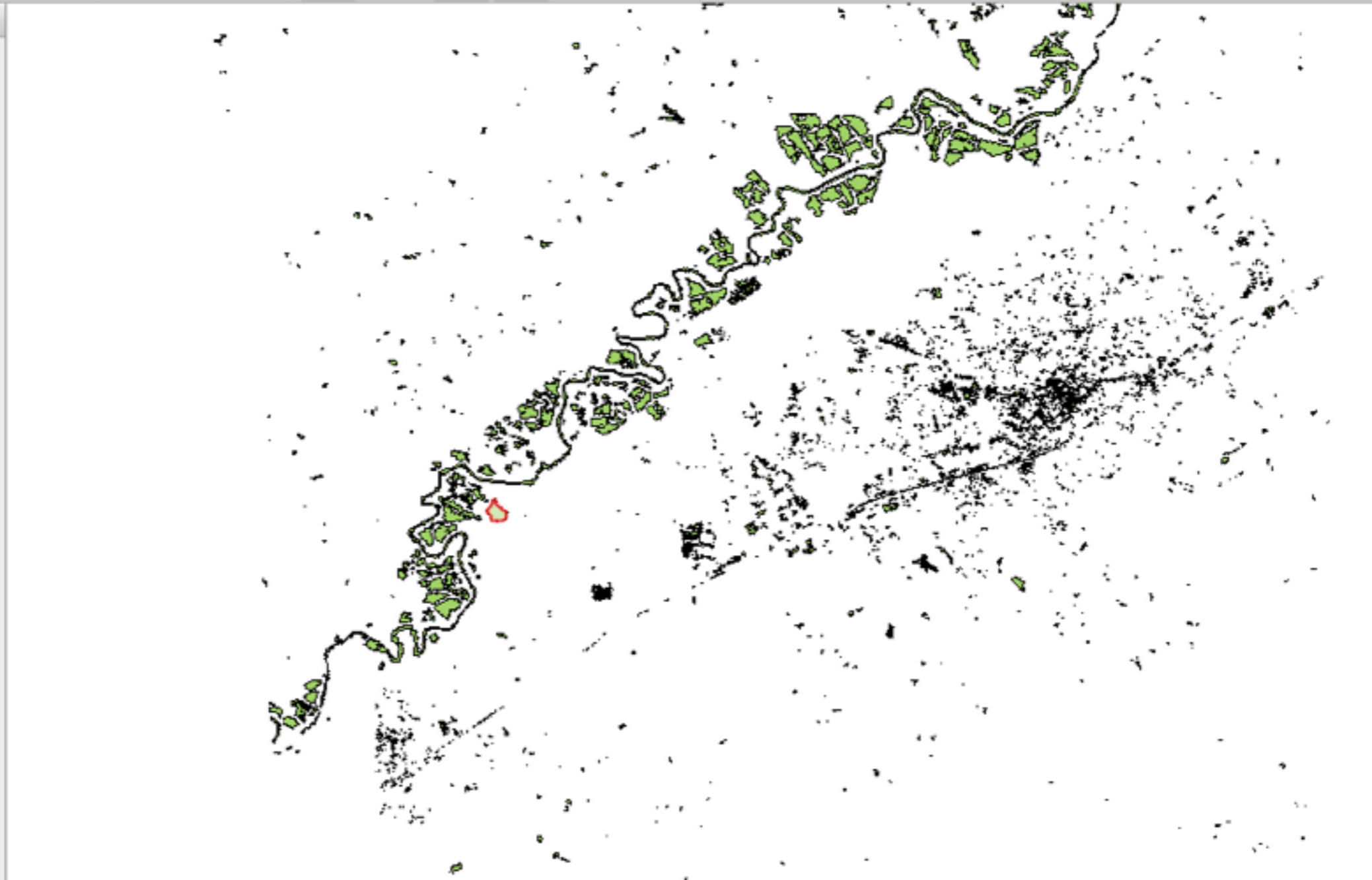
Shapefile



Layer Explorer

Layers

- tile\_21
  - Style



tile\_21

	FID	CLASS_1	CLASS_2	CLASS_3	CLASS_4	CLASS_5	CLASS_6	CLASS_7
1	0	0.760274	0.226027	0.013699	0.000000	0.000000	0.000000	0.000000





Estr. Mun. Cap. Oscar Francisco de Sales

Rod. Pedro Celeste

Av. Cinderela

Estr. do Barreiro

Tremembé

Taubaté

Caçapava

Caçapava Velha

383

383

383

383

SP-062

SP-062

SP-062

SP-062

SP-062

116

Google

Map navigation controls including a compass, zoom in (+) and zoom out (-) buttons, a street view pegman icon, and a vertical stack of three landscape icons (blue, yellow, green) with an upward arrow.

# Problemas

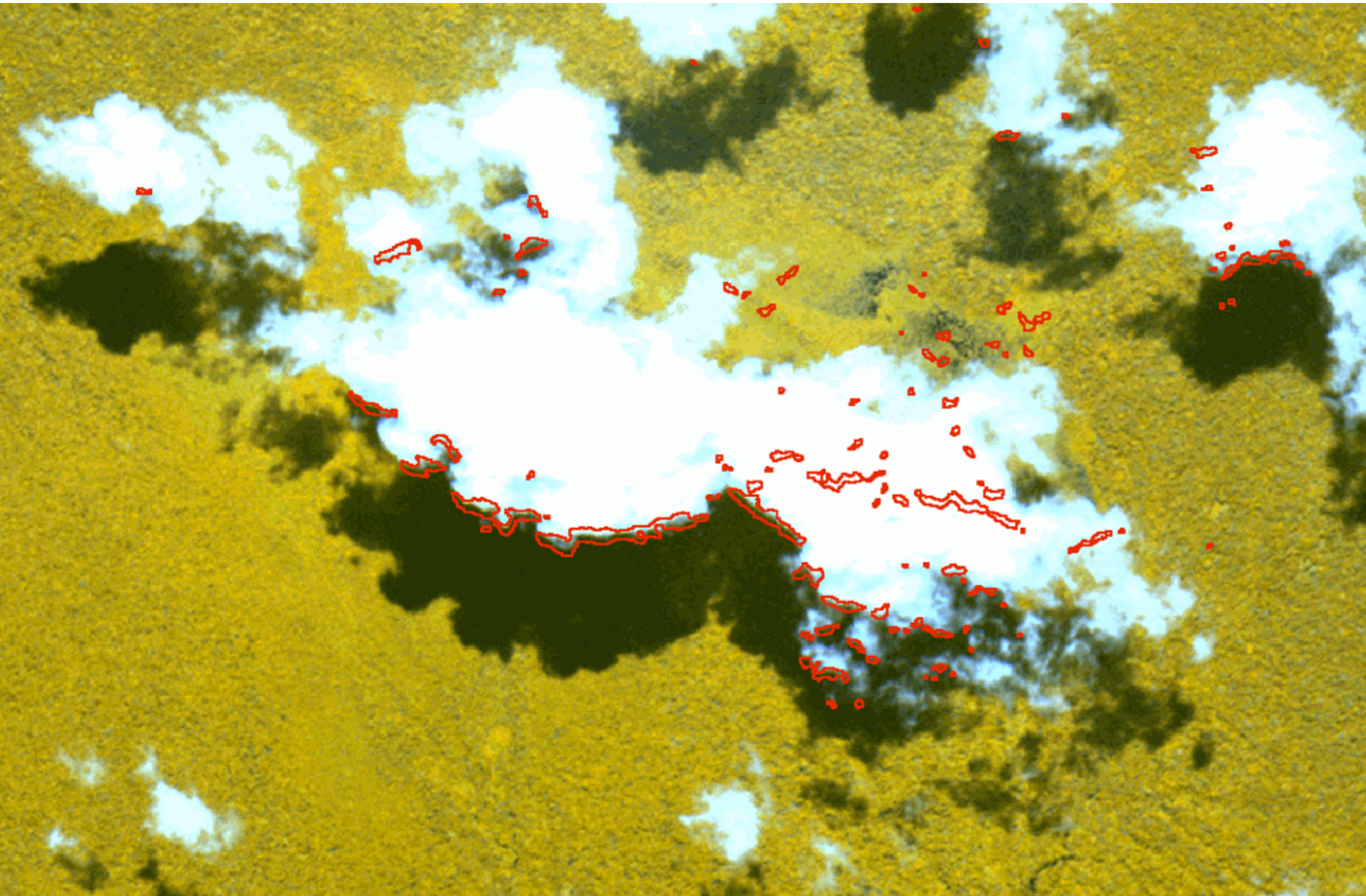
Omissão:

Cor diferente devido a turbidez, vegetação sub-aquática, lâmina muito rasa, reflexão especular, ...

Comissão:

Sombras, sombreado de nuvens, tipos específicos de asfalto, telhados e solos, área queimada, ...

# Nuvens



# Soluções

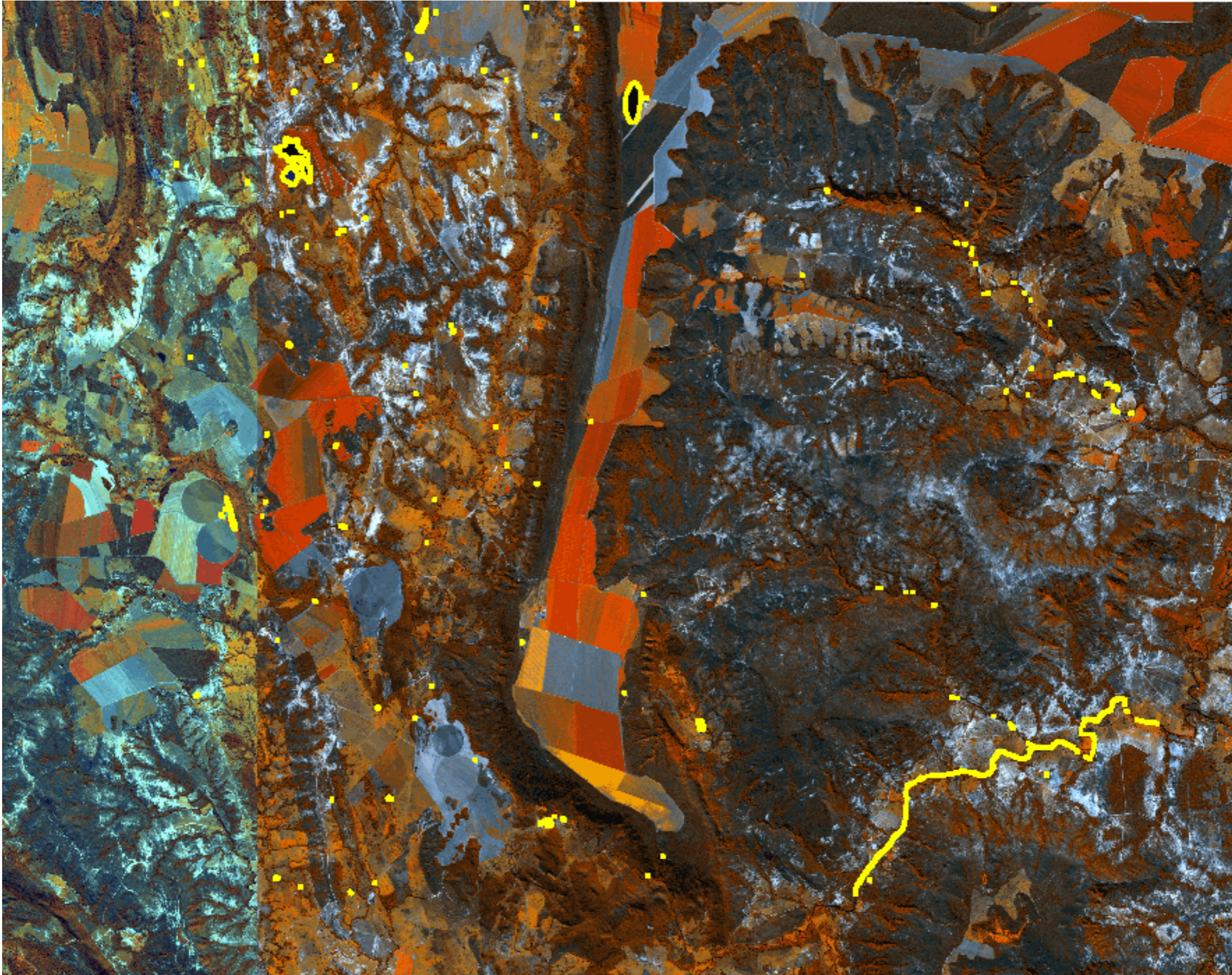
Área mínima - OK

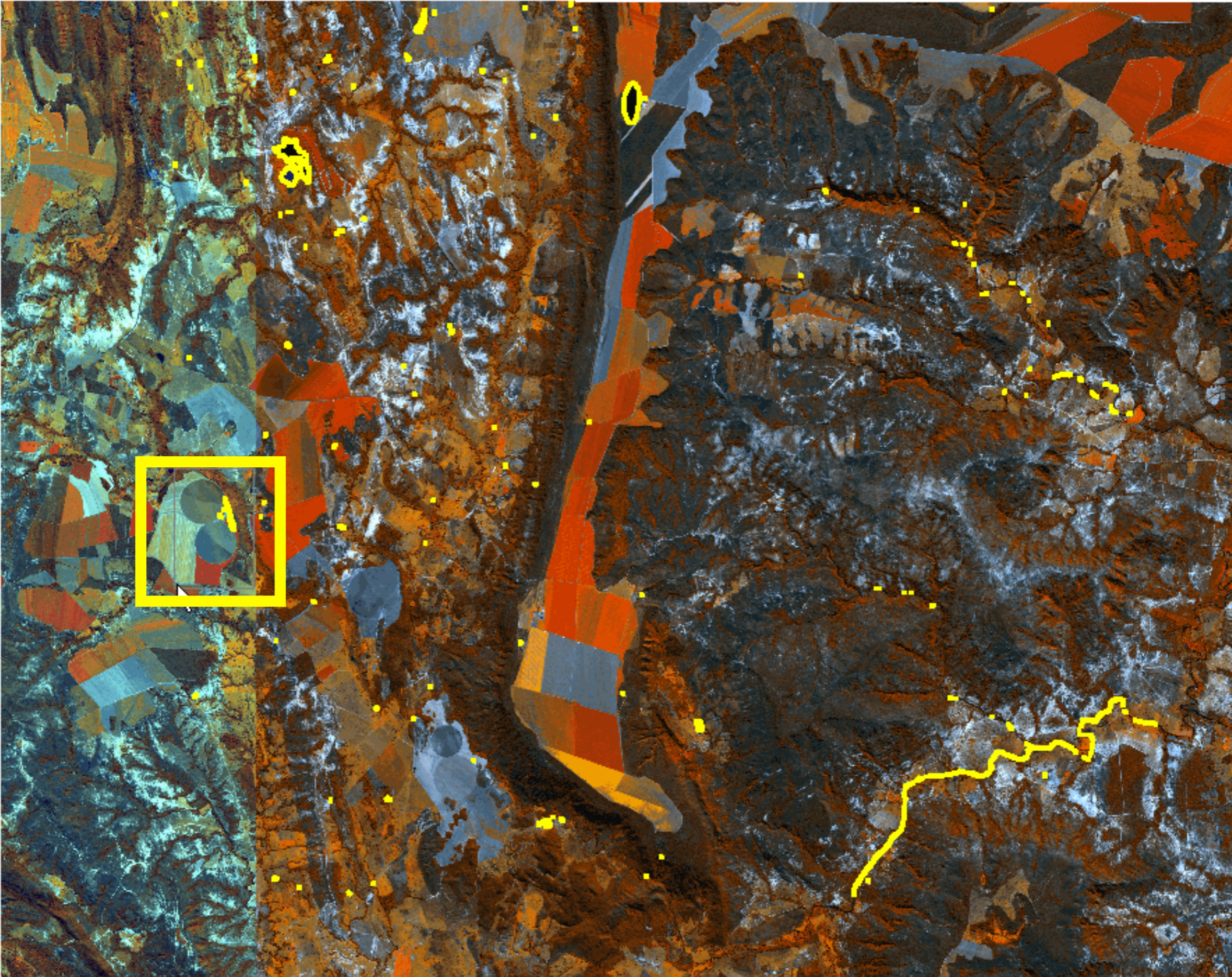
Grade de declividade - Remove sombras de relevo - OK

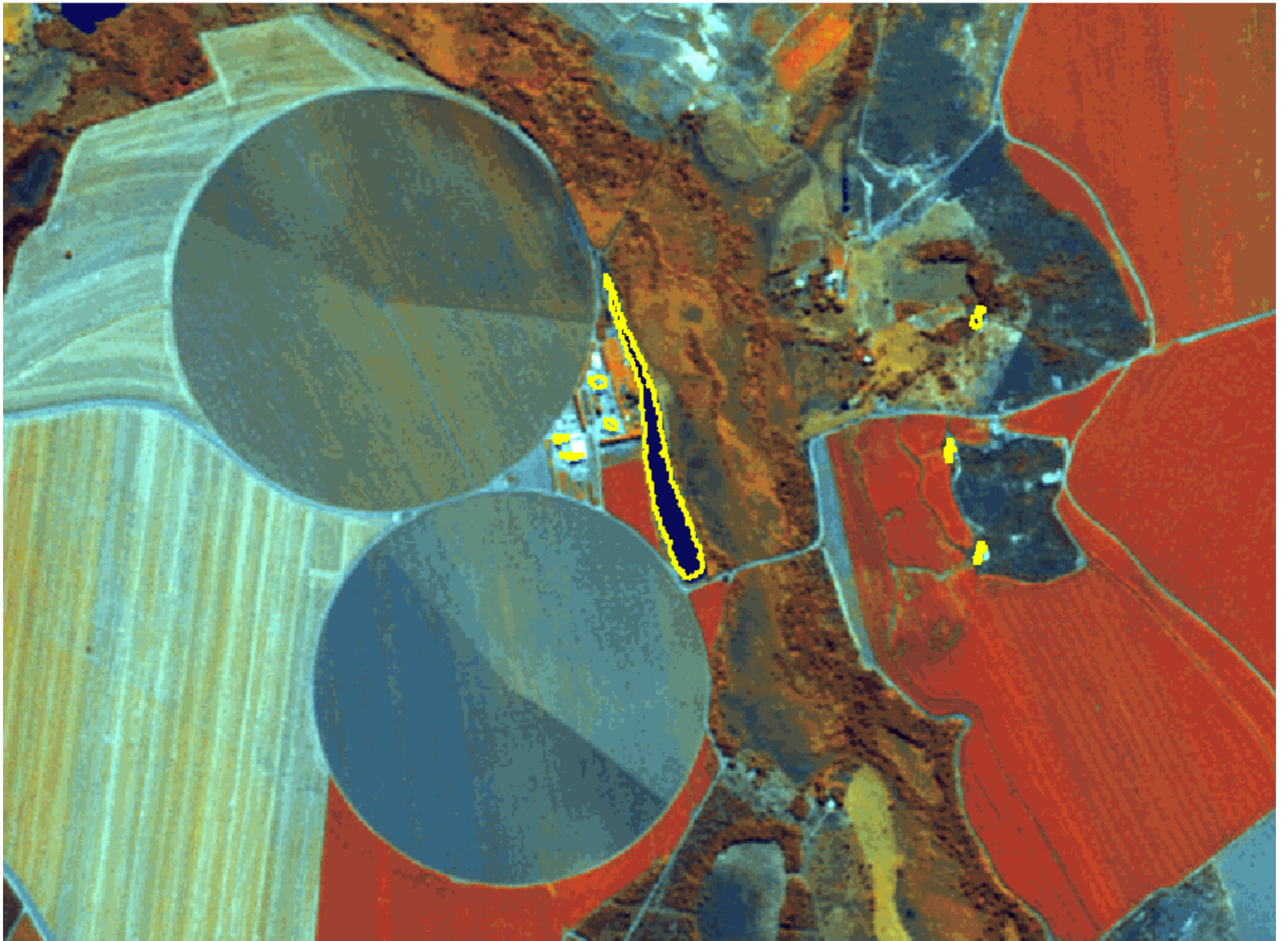
Máscara de áreas urbanas e estradas

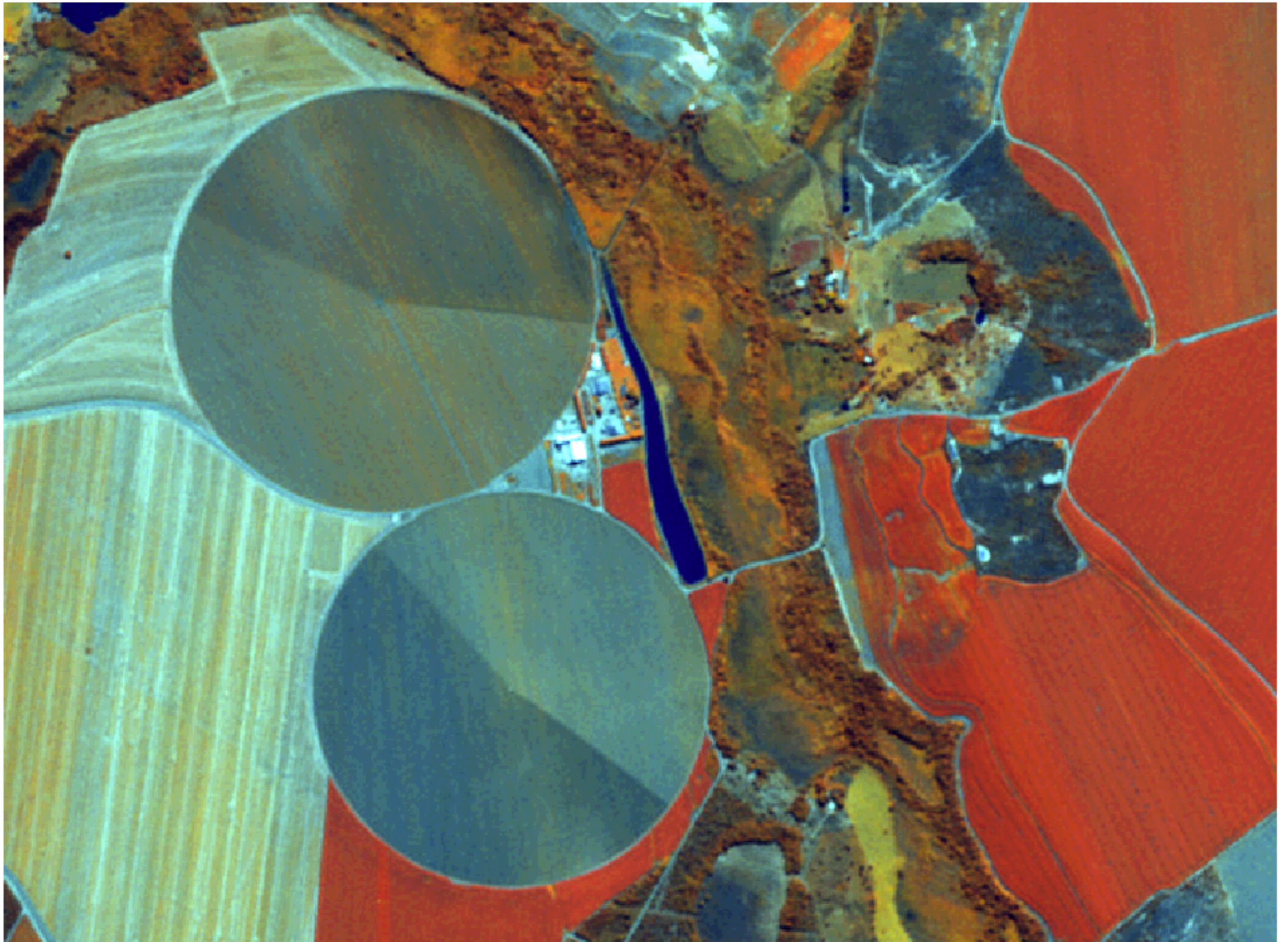
TerraHidro: HAND e Drenagem do SRTM 30m

Combinação com outras coberturas RapidEye

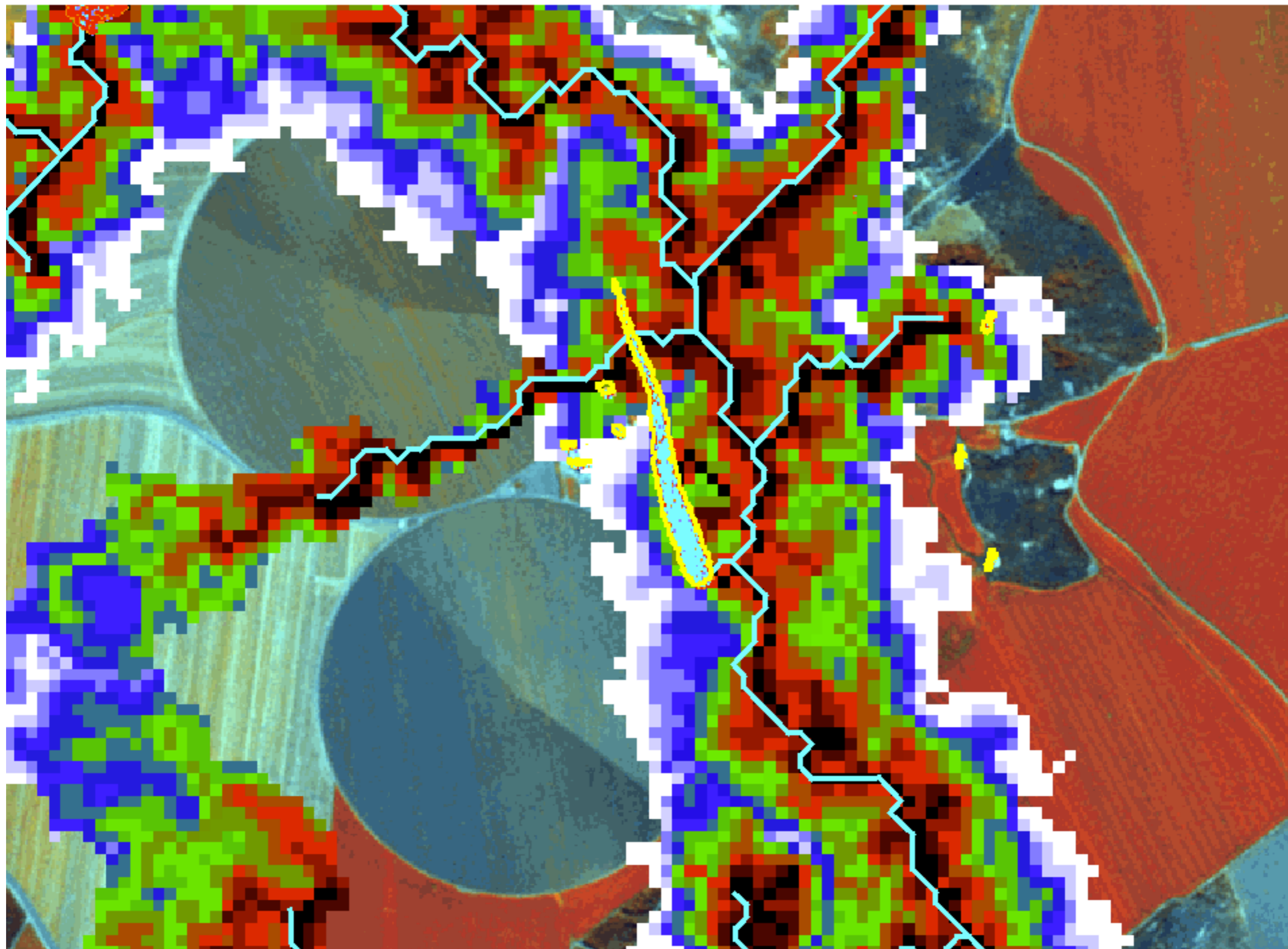


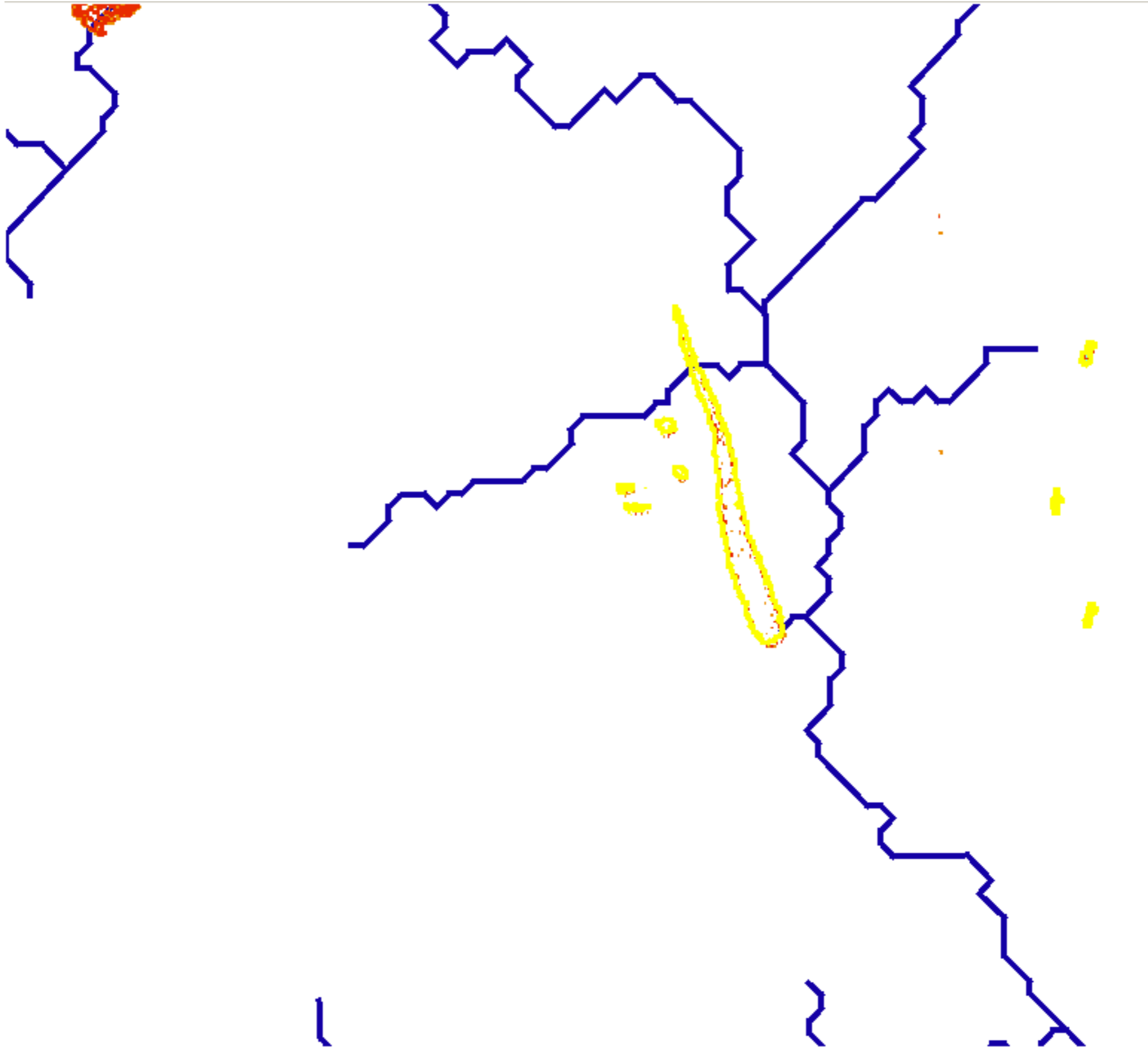


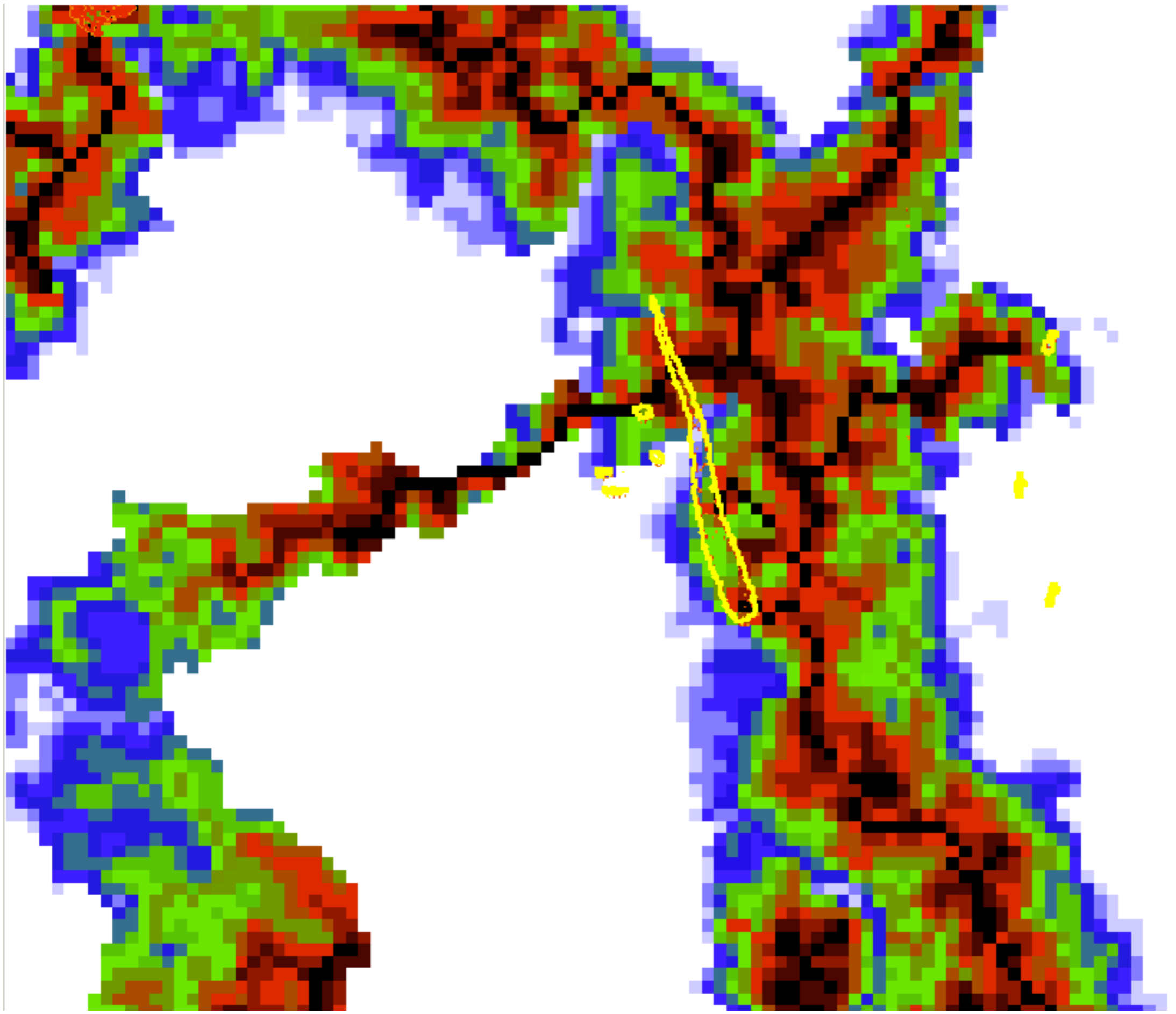














Pesquisa no Google Maps



Pt



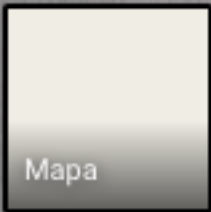
© 2016 Google

© 2016 Google

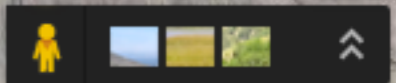
© 2016 Google

© 2016 Google

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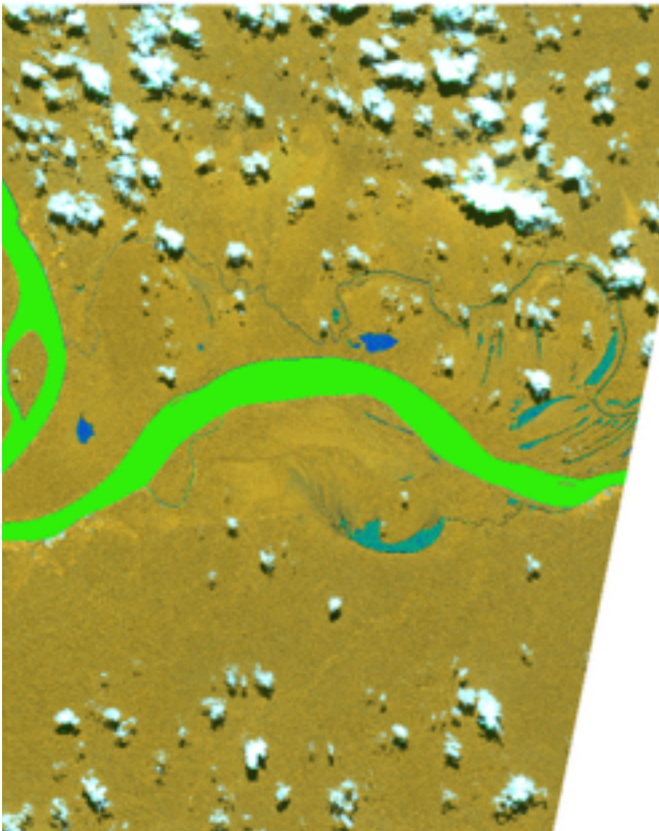


Google

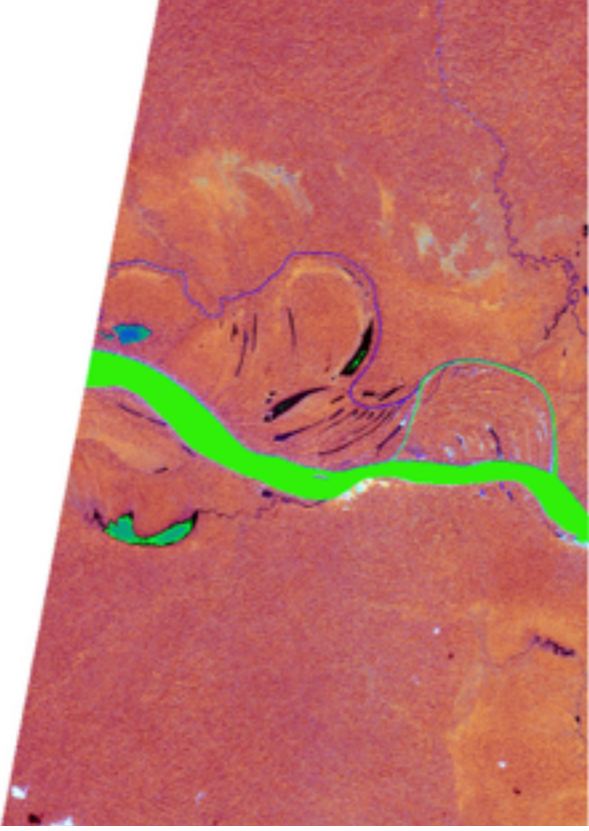


# Combinando Imagens de Datas Diferentes

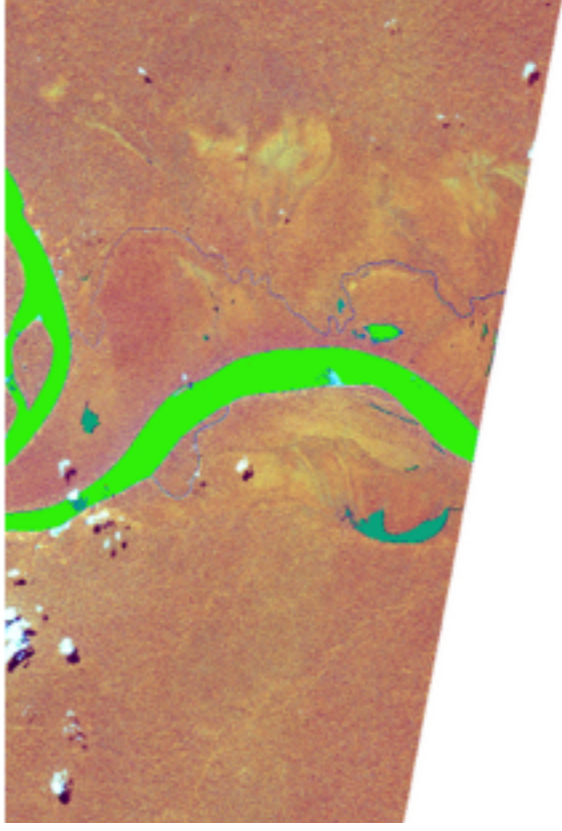
2011-08-10



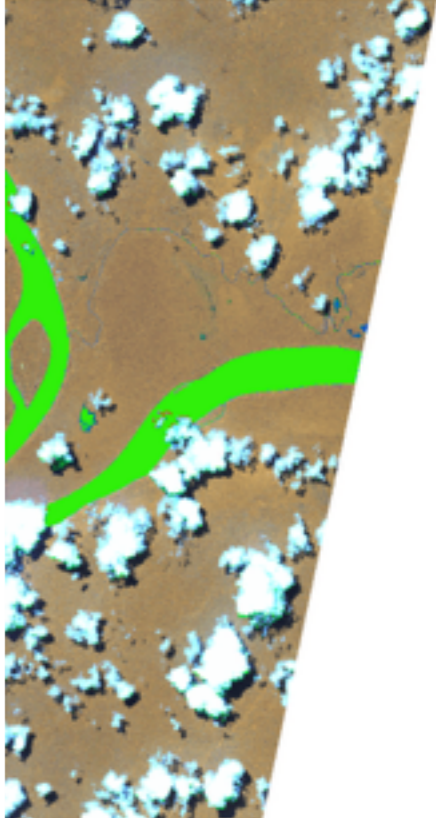
2012-08-05



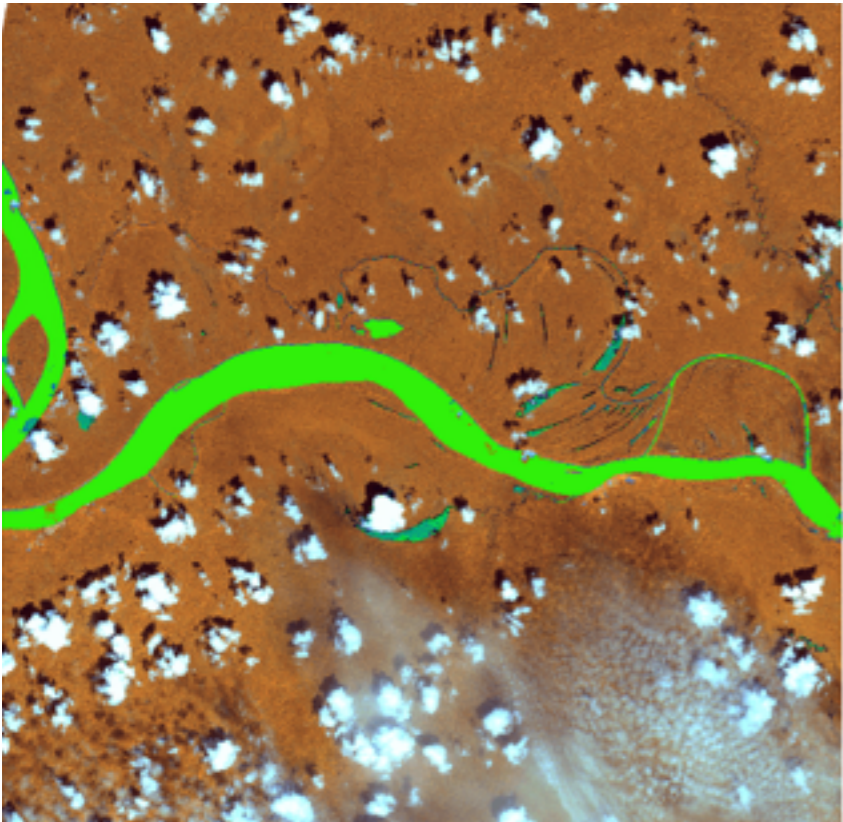
2012-08-29



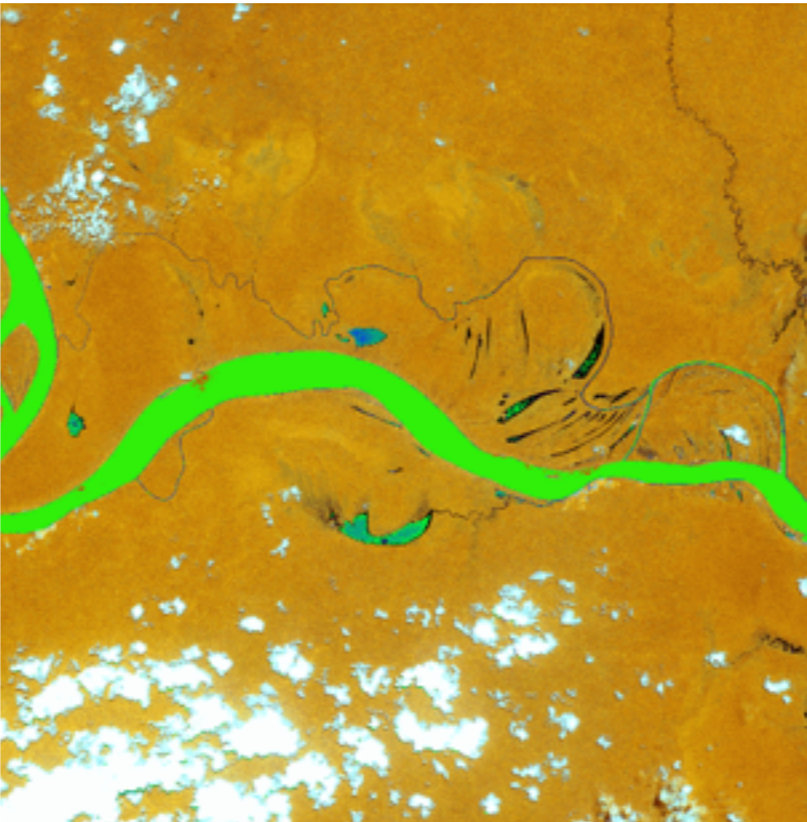
2013-09-13



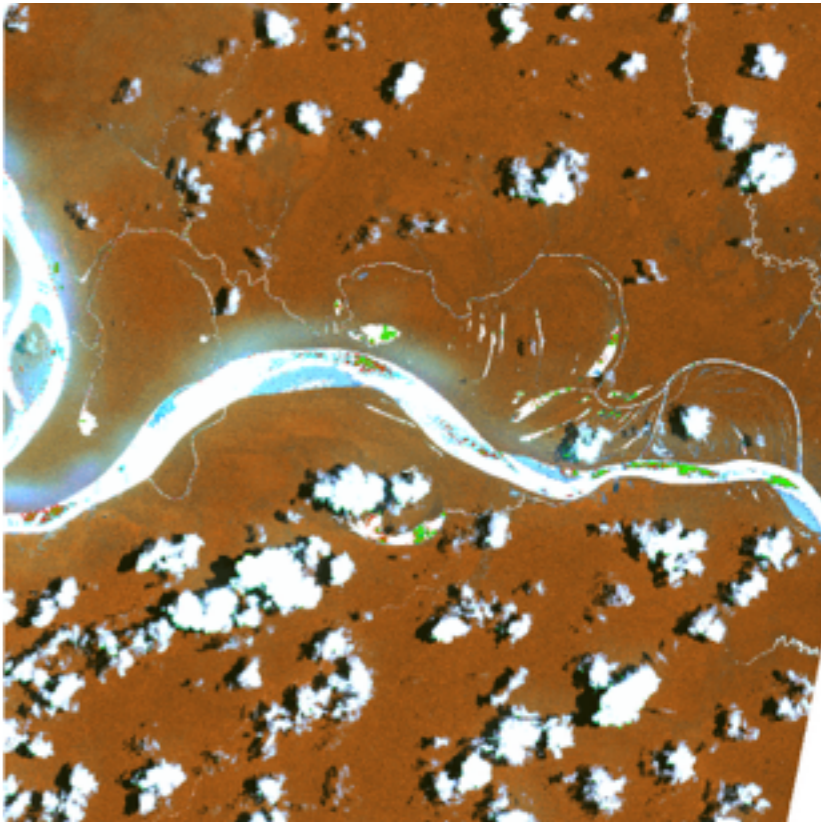
2013-11-23



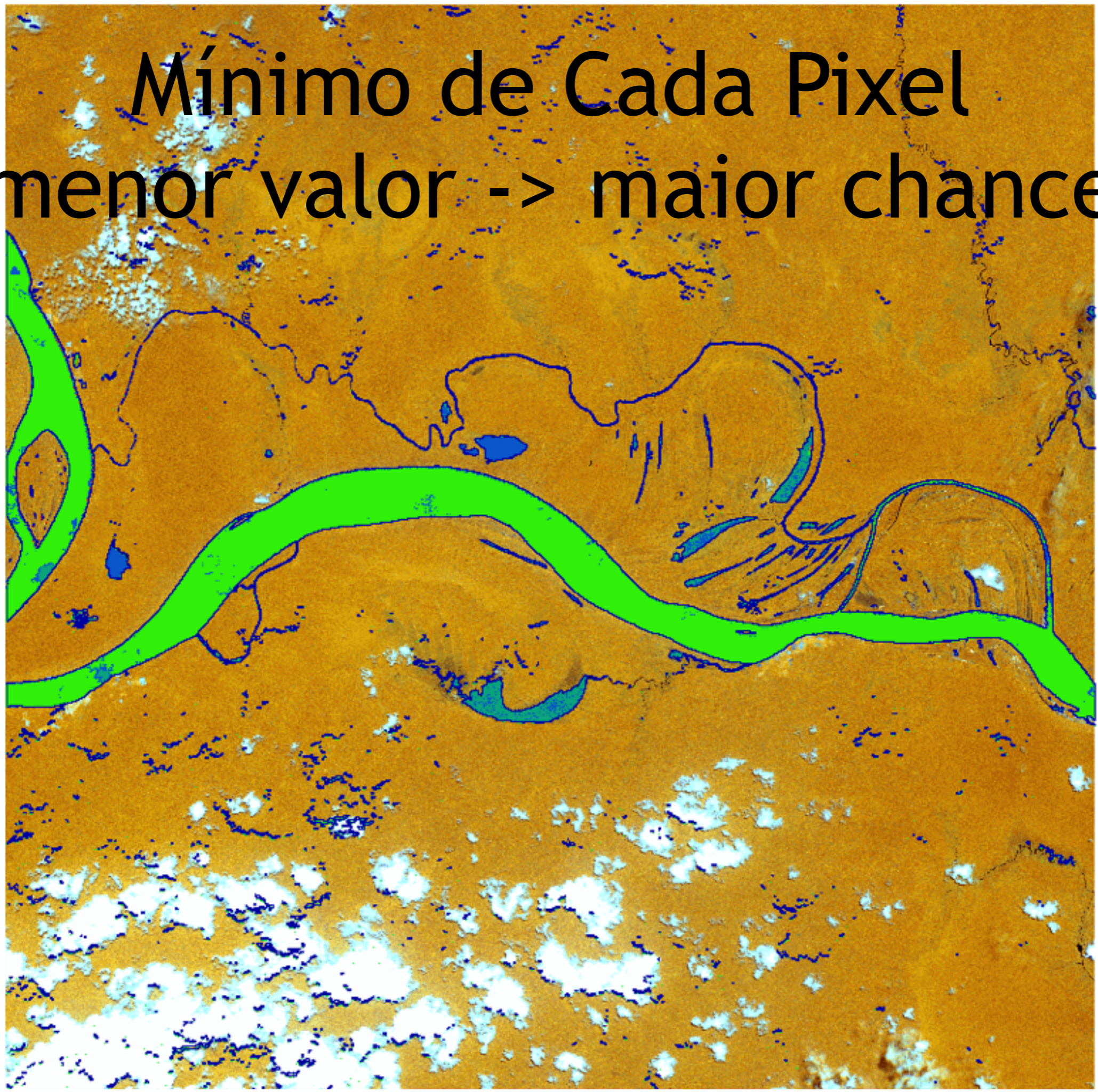
2014-09-29



2015-09-28



Mínimo de Cada Pixel  
(menor valor -> maior chance)





2011-08-10

SPRING-5.4.2 [Aguas][RioIca]

Arquivo Editar Exibir Imagem Temático MNT Cadastral Rede Análise SCarta Executar Ferramentas TerraLib Plugins Ajuda

Auto 1/ 88530.648438 Inativa ?

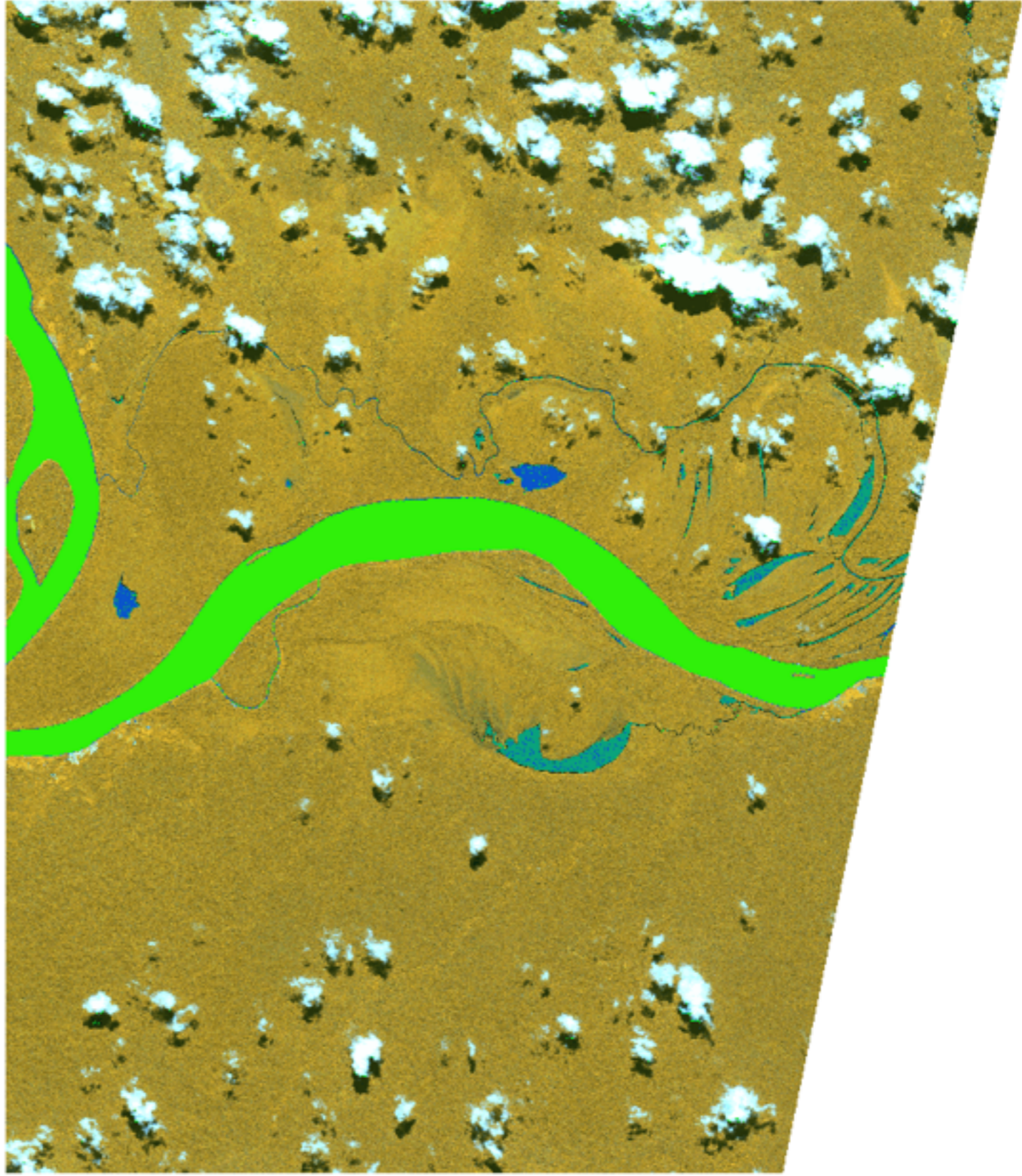
Painel de Controle

Tela Ativa : Auxiliar

PI Disponíveis | PI Selecionados

Categoria / Plano de Informação

- (C) CAT\_Cadastral
  - ( ) tile\_0
- (V) CAT\_Imagem
  - (S) 1937713\_2011-08-10\_543
  - ( ) 1937713\_2012-08-05\_543
  - ( ) 1937713\_2012-08-29\_543
  - ( ) 1937713\_2013-09-13\_543
  - ( ) 1937713\_2013-11-23\_543
  - ( ) 1937713\_2014-09-29\_543
  - ( ) 1937713\_2015-09-28\_543
  - ( ) 1937713\_tile
  - ( ) 1937713\_2014-09-29\_W
  - ( ) 1937713\_2013-09-13\_W
  - (M) 1937713\_2011-08-10\_W
  - ( ) 1937713\_2013-11-23\_W
  - ( ) 1937713\_2012-08-05\_W
  - ( ) 1937713\_2012-08-29\_W
  - ( ) 1937713\_2015-09-28\_W



M R G B

Principal Auxiliar Tela 2 Tela 3 Tela 4

PI: 1937713\_2011-08-10\_W



2011-08-10

SPRING-5.4.2 [Aguas][RioIca]

Arquivo Editar Exibir Imagem Temático MNT Cadastral Rede Análise SCarta Executar Ferramentas TerraLib Plugins Ajuda

Auto 1/ 27371.302734 Inativa ?

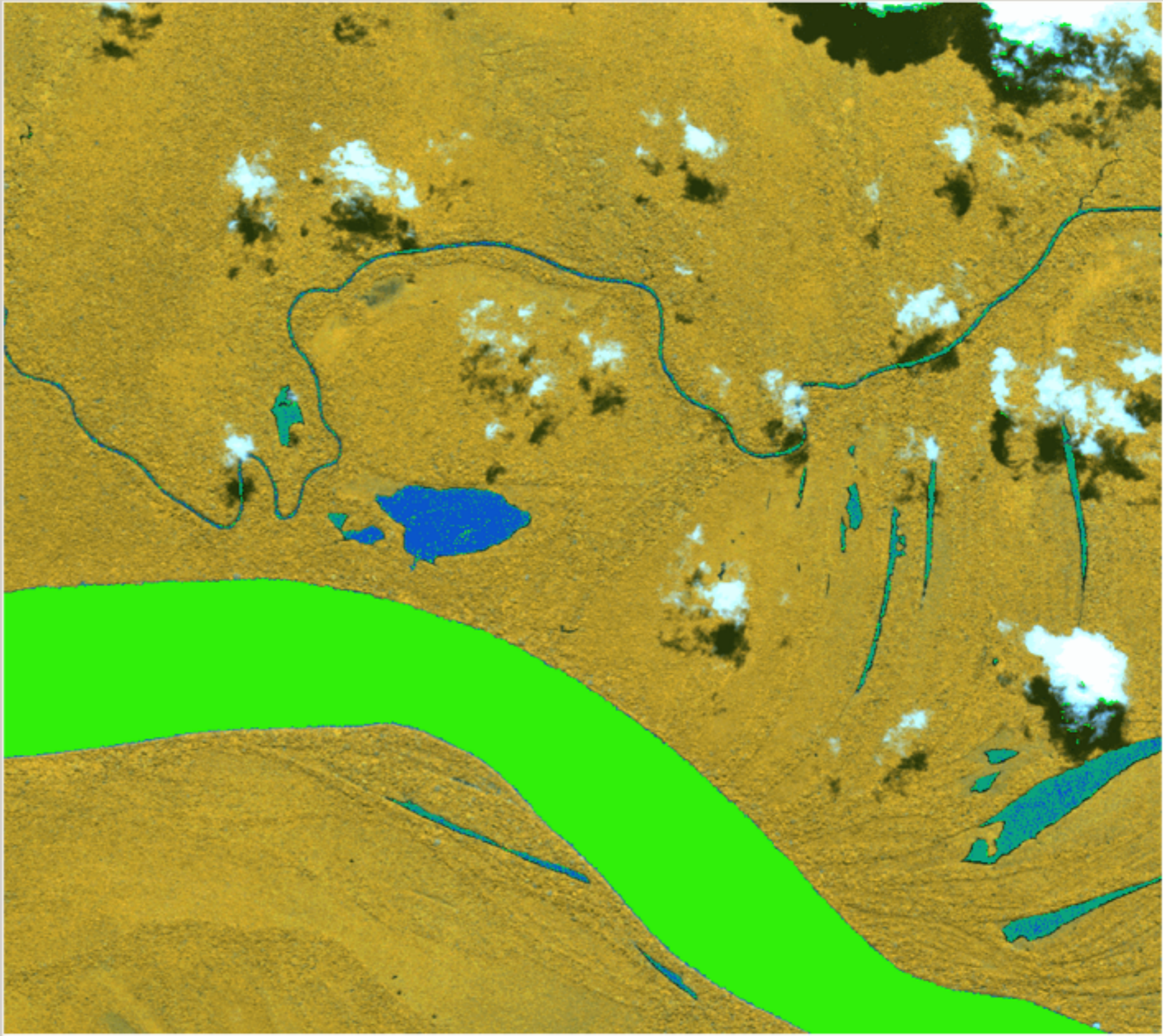
Painel de Controle

Tela Ativa : Auxiliar

PI Disponíveis | PI Selecionados

Categoria / Plano de Informação

- CAT\_Cadastral
  - tile\_0
- CAT\_Imagem
  - 1937713\_2011-08-10\_543
  - 1937713\_2012-08-05\_543
  - 1937713\_2012-08-29\_543
  - 1937713\_2013-09-13\_543
  - 1937713\_2013-11-23\_543
  - 1937713\_2014-09-29\_543
  - 1937713\_2015-09-28\_543
  - 1937713\_tile
  - 1937713\_2014-09-29\_W
  - 1937713\_2013-09-13\_W
  - 1937713\_2011-08-10\_W
  - 1937713\_2013-11-23\_W
  - 1937713\_2012-08-05\_W
  - 1937713\_2012-08-29\_W
  - 1937713\_2015-09-28\_W

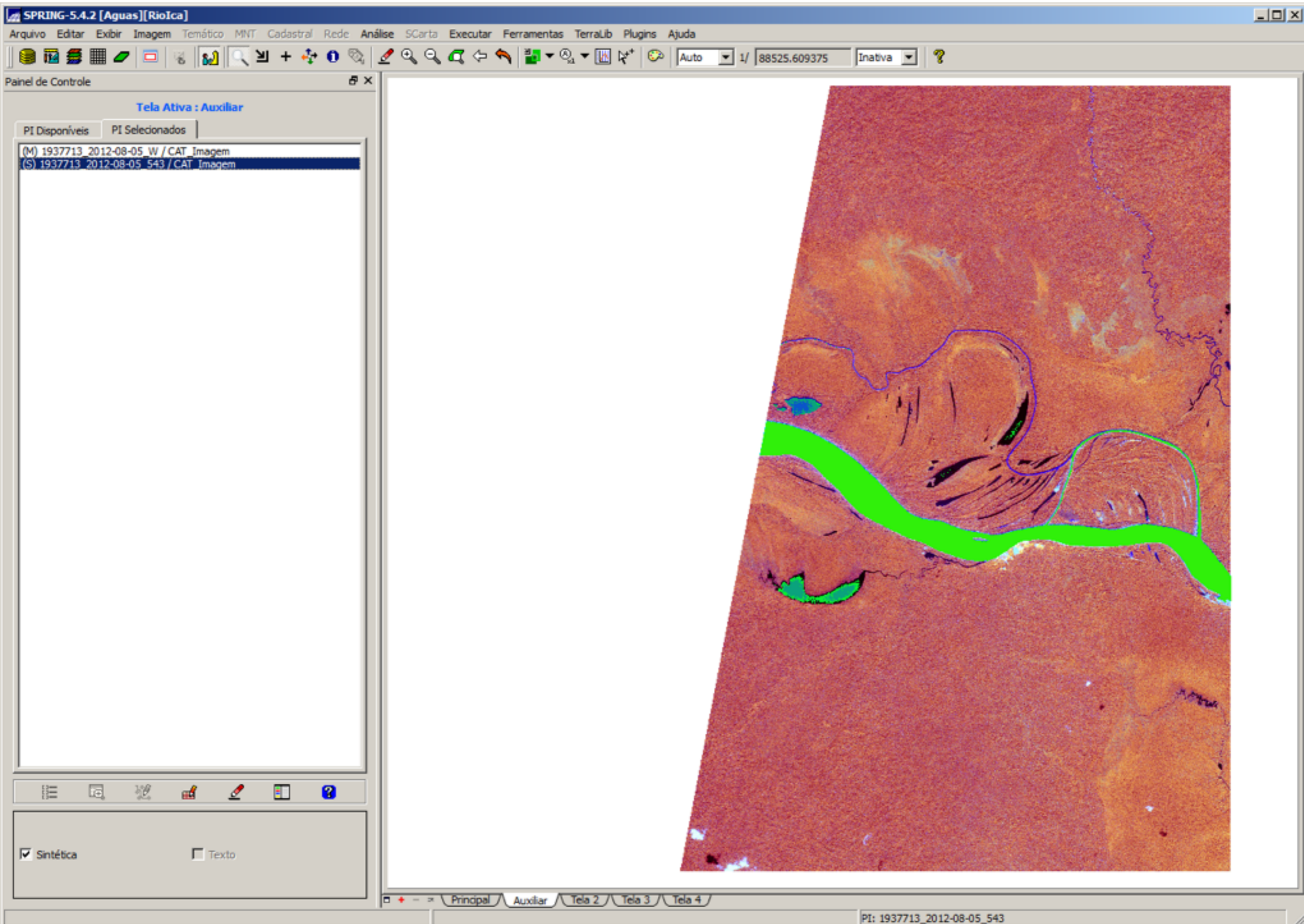


M  Texto  
 R  G  B

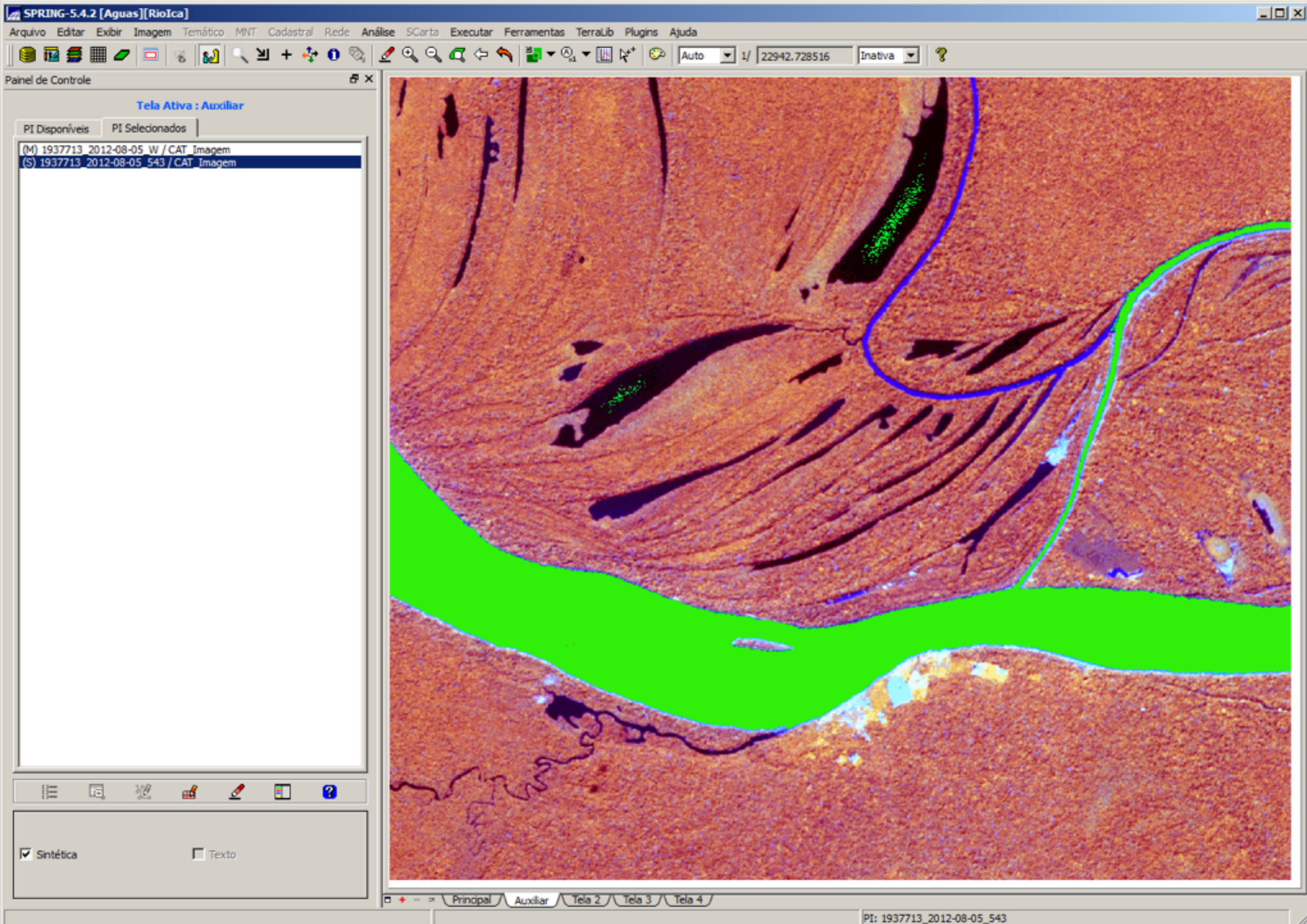
Principal Auxiliar Tela 2 Tela 3 Tela 4

PI: 1937713\_2011-08-10\_W

2012-08-05



2012-08-05



2012-08-29

SPRING-5.4.2 [Aguas][RioIca]

Arquivo Editar Exibir Imagem Temático MNT Cadastral Rede Análise SCarta Executar Ferramentas TerraLib Plugins Ajuda

Auto 1/ 86661.812500 Inativa ?

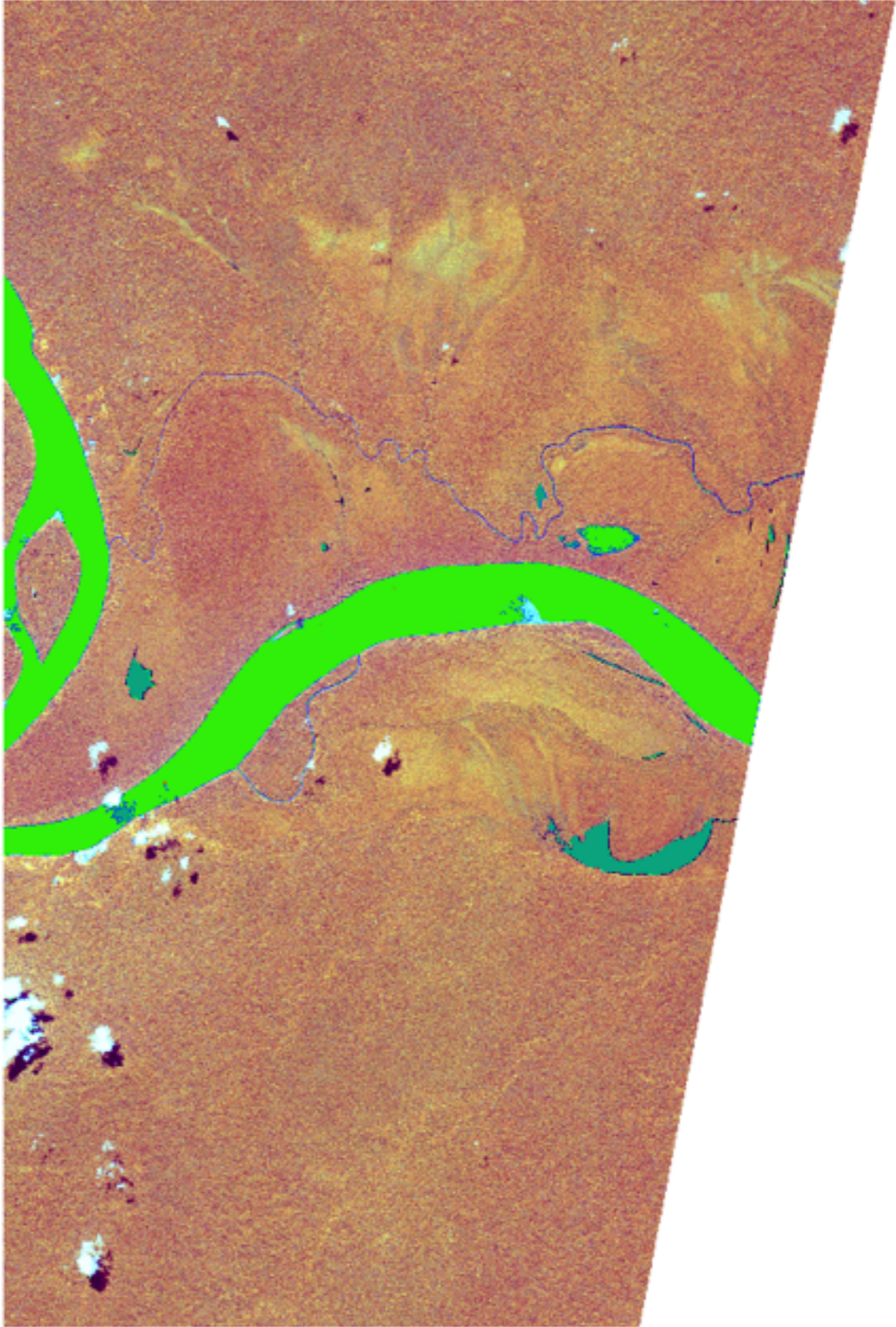
Painel de Controle

Tela Ativa : Auxiliar

PI Disponíveis | PI Selecionados

Categoria / Plano de Informação

- ( ) CAT\_Cadastral
  - ( ) tile\_0
- (V) CAT\_Imagem
  - ( ) 1937713\_2011-08-10\_543
  - ( ) 1937713\_2012-08-05\_543
  - (S) 1937713\_2012-08-29\_543
  - ( ) 1937713\_2013-09-13\_543
  - ( ) 1937713\_2013-11-23\_543
  - ( ) 1937713\_2014-09-29\_543
  - ( ) 1937713\_2015-09-28\_543
  - ( ) 1937713\_tile
  - ( ) 1937713\_2014-09-29\_W
  - ( ) 1937713\_2013-09-13\_W
  - ( ) 1937713\_2011-08-10\_W
  - ( ) 1937713\_2013-11-23\_W
  - ( ) 1937713\_2012-08-05\_W
  - (M) 1937713\_2012-08-29\_W
  - ( ) 1937713\_2015-09-28\_W



M  R  Texto  G  B

Principal Auxiliar Tela 2 Tela 3 Tela 4

PI: 1937713\_2012-08-29\_W

2012-08-29

SPRING-5.4.2 [Aguas][RioIca]

Arquivo Editar Exibir Imagem Temático MNT Cadastral Rede Análise SCarta Executar Ferramentas TerraLib Plugins Ajuda

Auto 1/ 15785.353516 Inativa ?

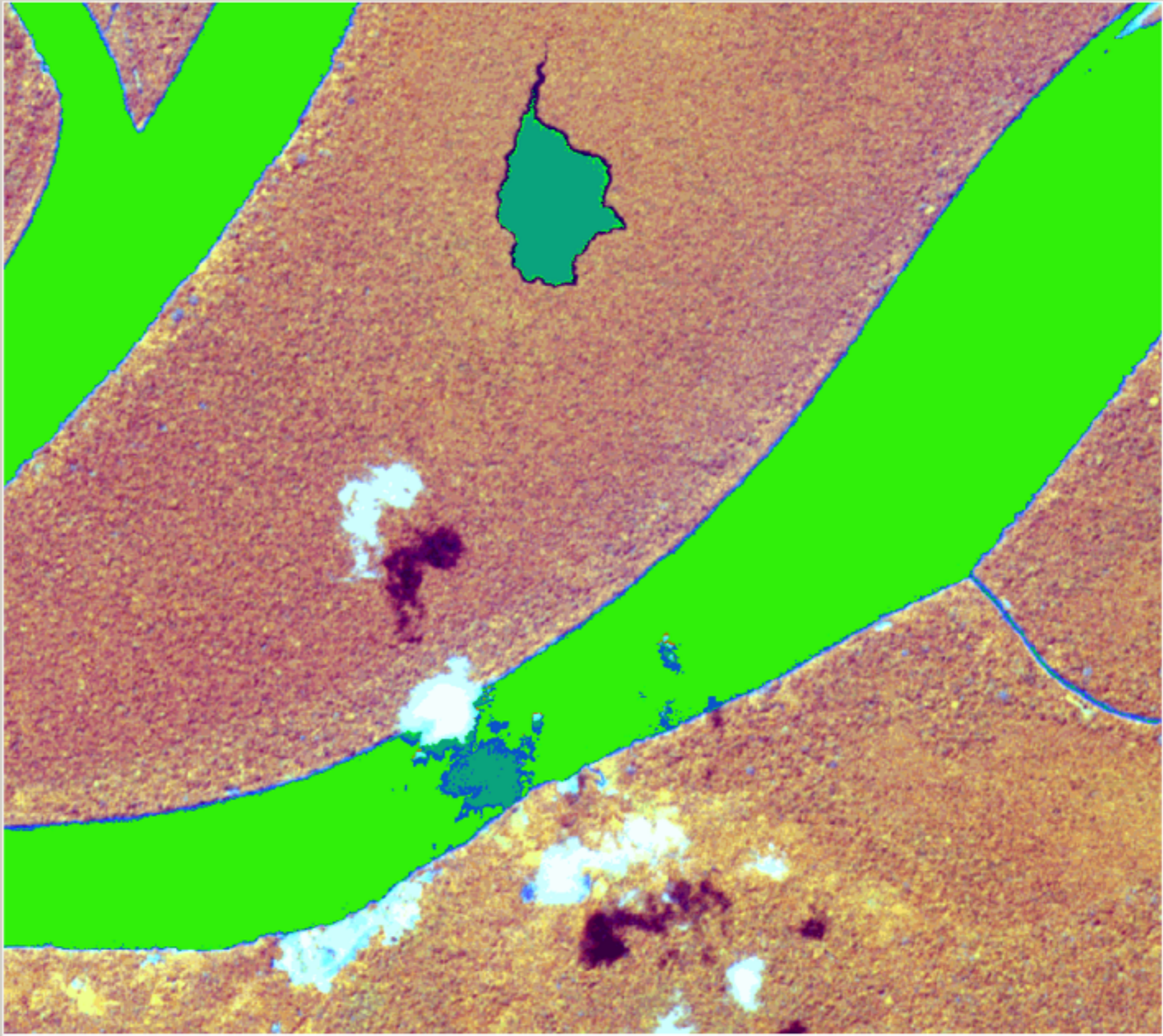
Painel de Controle

Tela Ativa : Auxiliar

PI Disponíveis | PI Selecionados

Categoria / Plano de Informação

- ( ) CAT\_Cadastral
  - ( ) tile\_0
- (V) CAT\_Imagem
  - ( ) 1937713\_2011-08-10\_543
  - ( ) 1937713\_2012-08-05\_543
  - (S) 1937713\_2012-08-29\_543
  - ( ) 1937713\_2013-09-13\_543
  - ( ) 1937713\_2013-11-23\_543
  - ( ) 1937713\_2014-09-29\_543
  - ( ) 1937713\_2015-09-28\_543
  - ( ) 1937713\_tile
  - ( ) 1937713\_2014-09-29\_W
  - ( ) 1937713\_2013-09-13\_W
  - ( ) 1937713\_2011-08-10\_W
  - ( ) 1937713\_2013-11-23\_W
  - ( ) 1937713\_2012-08-05\_W
  - (M) 1937713\_2012-08-29\_W
  - ( ) 1937713\_2015-09-28\_W



M  R  Texto  G  B

Principal Auxiliar Tela 2 Tela 3 Tela 4

PI: 1937713\_2012-08-29\_W

2013-09-13

SPRING-5.4.2 [Aguas][RioIca]

Arquivo Editar Exibir Imagem Temático MNT Cadastral Rede Análise SCarta Executar Ferramentas TerraLib Plugins Ajuda

Auto 1/ 86661.812500 Inativa ?

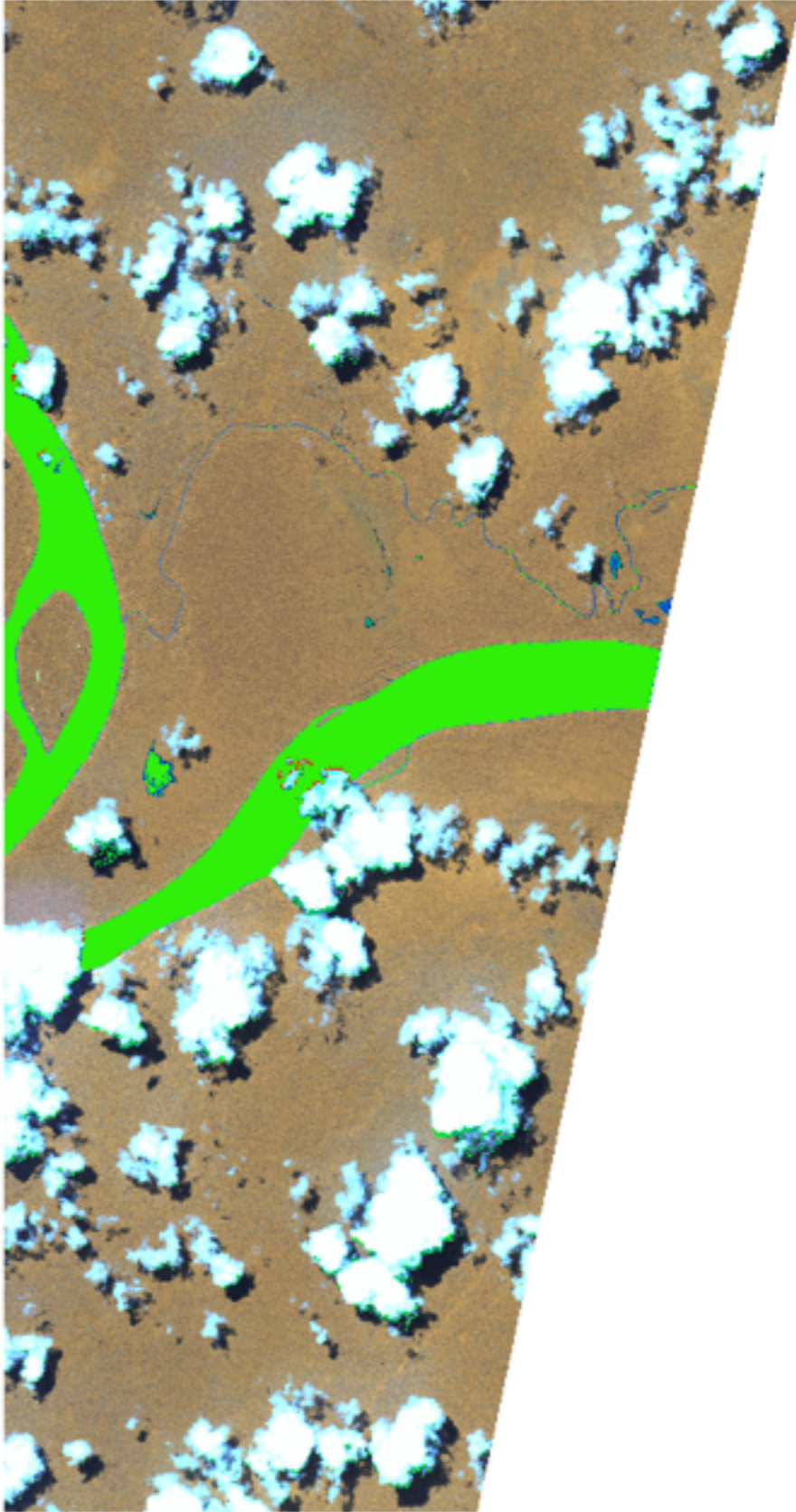
Painel de Controle

Tela Ativa : Auxiliar

PI Disponíveis | PI Selecionados

Categoria / Plano de Informação

- ( ) CAT\_Cadastral
  - ( ) tile\_0
- (V) CAT\_Imagem
  - ( ) 1937713\_2011-08-10\_543
  - ( ) 1937713\_2012-08-05\_543
  - ( ) 1937713\_2012-08-29\_543
  - (S) 1937713\_2013-09-13\_543
  - ( ) 1937713\_2013-11-23\_543
  - ( ) 1937713\_2014-09-29\_543
  - ( ) 1937713\_2015-09-28\_543
  - ( ) 1937713\_tile
  - ( ) 1937713\_2014-09-29\_W
  - (M) 1937713\_2013-09-13\_W
  - ( ) 1937713\_2011-08-10\_W
  - ( ) 1937713\_2013-11-23\_W
  - ( ) 1937713\_2012-08-05\_W
  - ( ) 1937713\_2012-08-29\_W
  - ( ) 1937713\_2015-09-28\_W



Sintética  Texto

Principal Auxiliar Tela 2 Tela 3 Tela 4

PI: 1937713\_2013-09-13\_543

2013-09-13

SPRING-5.4.2 [Aguas][RioIca]

Arquivo Editar Exibir Imagem Temático MNT Cadastral Rede Análise SCarta Executar Ferramentas TerraLib Plugins Ajuda

Auto 1/ 14831.875977 Inativa ?

Painel de Controle

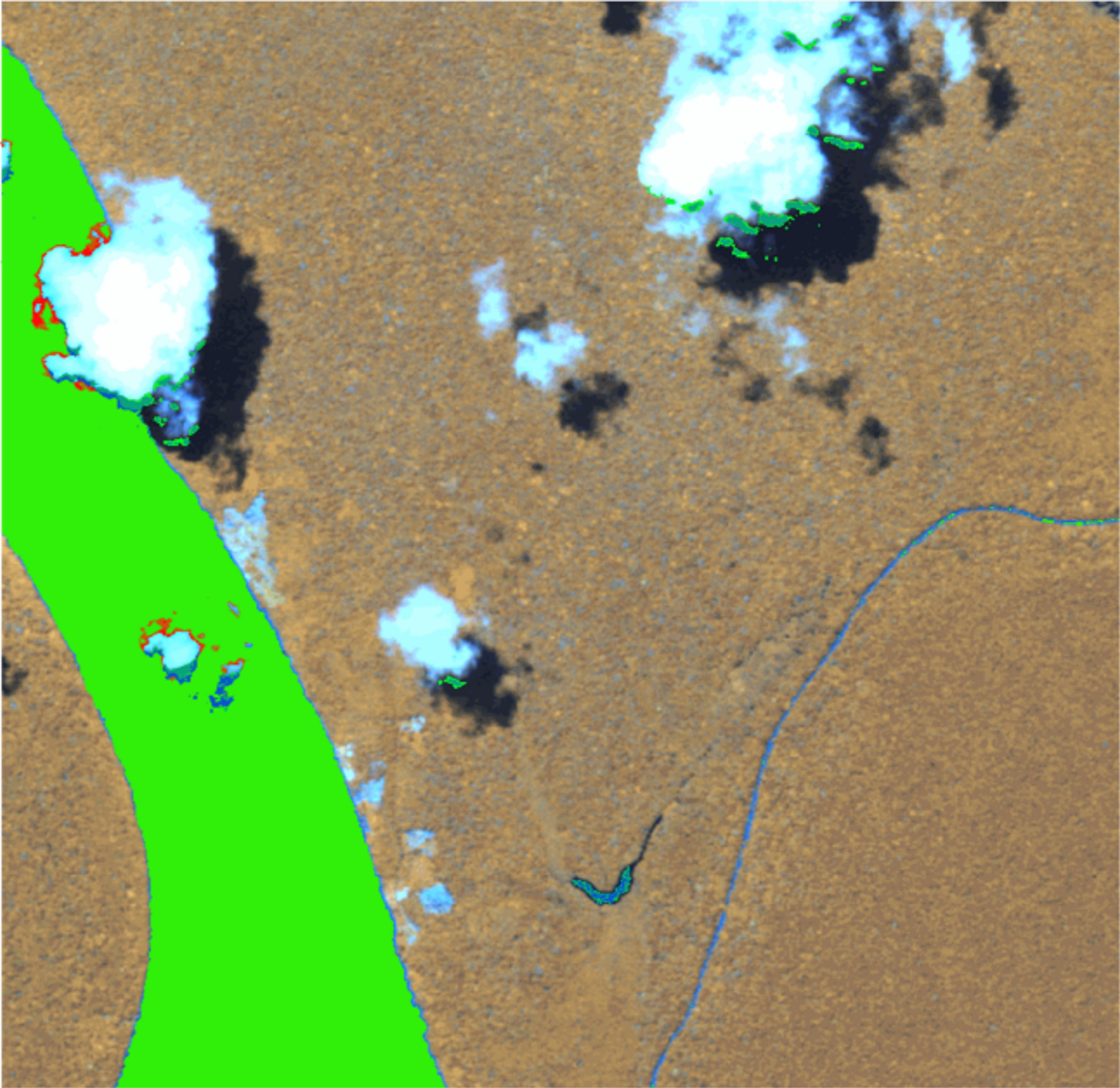
Tela Ativa : Auxiliar

PI Disponíveis | PI Selecionados

Categoria / Plano de Informação

- ( ) CAT\_Cadastral
  - ( ) tile\_0
- (V) CAT\_Imagem
  - ( ) 1937713\_2011-08-10\_543
  - ( ) 1937713\_2012-08-05\_543
  - ( ) 1937713\_2012-08-29\_543
  - (S) 1937713\_2013-09-13\_543
  - ( ) 1937713\_2013-11-23\_543
  - ( ) 1937713\_2014-09-29\_543
  - ( ) 1937713\_2015-09-28\_543
  - ( ) 1937713\_tile
  - ( ) 1937713\_2014-09-29\_W
  - (M) 1937713\_2013-09-13\_W
  - ( ) 1937713\_2011-08-10\_W
  - ( ) 1937713\_2013-11-23\_W
  - ( ) 1937713\_2012-08-05\_W
  - ( ) 1937713\_2012-08-29\_W
  - ( ) 1937713\_2015-09-28\_W

Sintética  Texto



Principal Auxiliar Tela 2 Tela 3 Tela 4

PI: 1937713\_2013-09-13\_543

2013-11-23

SPRING-5.4.2 [Aguas][RioIca]

Arquivo Editar Exibir Imagem Temático MNT Cadastral Rede Análise SCarta Executar Ferramentas TerraLib Plugins Ajuda

Auto 1/ 88525.609375 Inativa ?

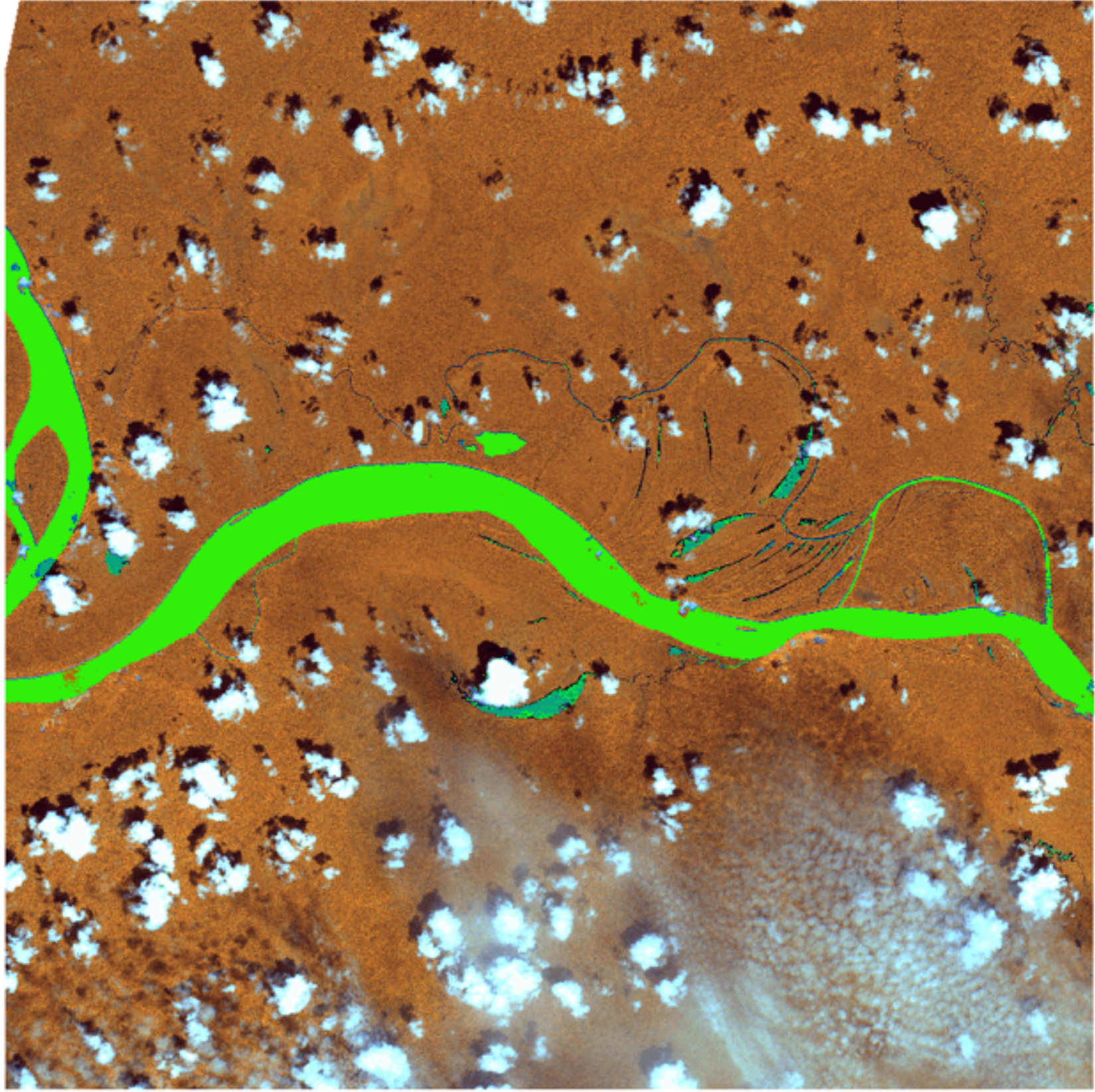
Painel de Controle

Tela Ativa : Auxiliar

PI Disponíveis | PI Seleccionados

Categoria / Plano de Informação

- ( ) CAT\_Cadastral
  - ( ) tile\_0
- (V) CAT\_Imagem
  - ( ) 1937713\_2011-08-10\_543
  - ( ) 1937713\_2012-08-05\_543
  - ( ) 1937713\_2012-08-29\_543
  - ( ) 1937713\_2013-09-13\_543
  - (S) 1937713\_2013-11-23\_543
  - ( ) 1937713\_2014-09-29\_543
  - ( ) 1937713\_2015-09-28\_543
  - ( ) 1937713\_tile
  - ( ) 1937713\_2014-09-29\_W
  - ( ) 1937713\_2013-09-13\_W
  - ( ) 1937713\_2011-08-10\_W
  - (M) 1937713\_2013-11-23\_W
  - ( ) 1937713\_2012-08-05\_W
  - ( ) 1937713\_2012-08-29\_W
  - ( ) 1937713\_2015-09-28\_W



Sintética  Texto

Principal Auxiliar Tela 2 Tela 3 Tela 4

PI: 1937713\_2013-11-23\_543



2013-11-23

SPRING-5.4.2 [Aguas][RioIca]

Arquivo Editar Exibir Imagem Temático MNT Cadastral Rede Análise SCarta Executar Ferramentas TerraLib Plugins Ajuda

Auto 1/ 22262.011719 Inativa ?

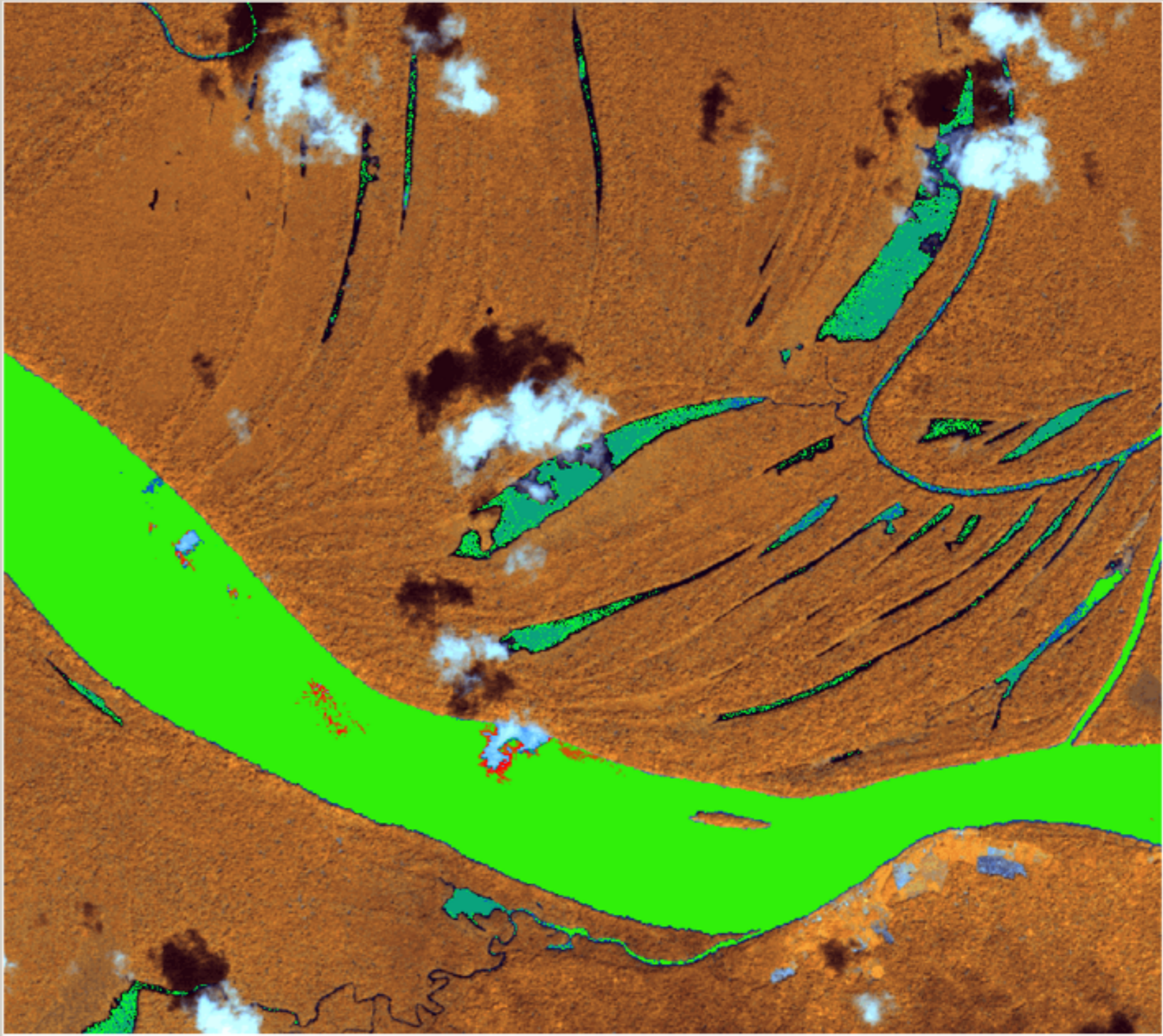
Painel de Controle

Tela Ativa : Auxiliar

PI Disponíveis | PI Selecionados

Categoria / Plano de Informação

- ( ) CAT\_Cadastral
  - ( ) tile\_0
- (V) CAT\_Imagem
  - ( ) 1937713\_2011-08-10\_543
  - ( ) 1937713\_2012-08-05\_543
  - ( ) 1937713\_2012-08-29\_543
  - ( ) 1937713\_2013-09-13\_543
  - (S) 1937713\_2013-11-23\_543
  - ( ) 1937713\_2014-09-29\_543
  - ( ) 1937713\_2015-09-28\_543
  - ( ) 1937713\_tile
  - ( ) 1937713\_2014-09-29\_W
  - ( ) 1937713\_2013-09-13\_W
  - ( ) 1937713\_2011-08-10\_W
  - (M) 1937713\_2013-11-23\_W
  - ( ) 1937713\_2012-08-05\_W
  - ( ) 1937713\_2012-08-29\_W
  - ( ) 1937713\_2015-09-28\_W



Sintética  Texto

Principal Auxiliar Tela 2 Tela 3 Tela 4

PI: 1937713\_2013-11-23\_543

2014-09-29

SPRING-5.4.2 [Aguas][RioIca]

Arquivo Editar Exibir Imagem Temático MNT Cadastral Rede Análise SCarta Executar Ferramentas TerraLib Plugins Ajuda

Auto 1/ 86661.812500 Inativa ?

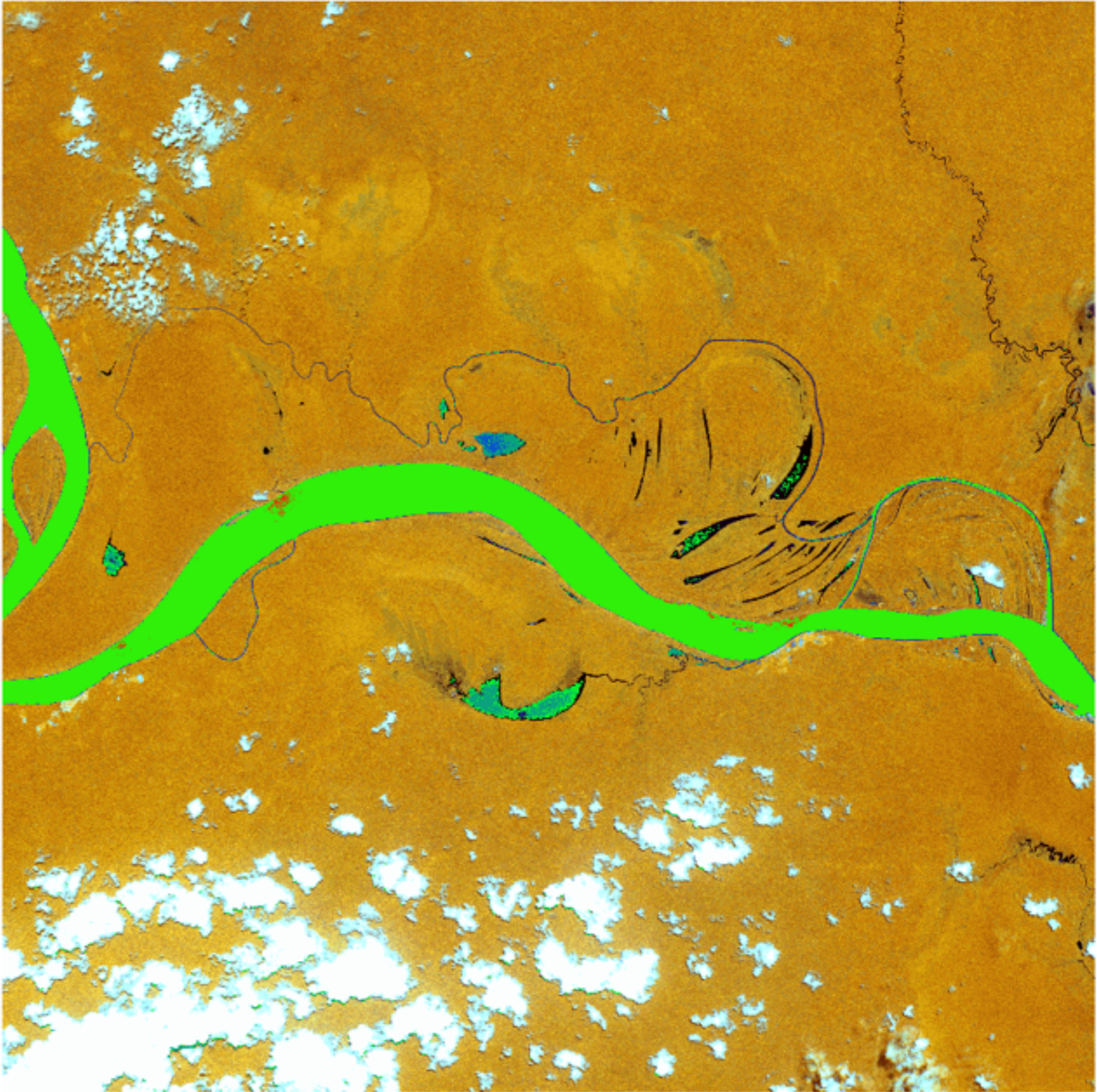
Painel de Controle

Tela Ativa : Auxiliar

PI Disponíveis | PI Seleccionados

Categoria / Plano de Informação

- ( ) CAT\_Cadastral
  - ( ) tile\_0
- (V) CAT\_Imagem
  - ( ) 1937713\_2011-08-10\_543
  - ( ) 1937713\_2012-08-05\_543
  - ( ) 1937713\_2012-08-29\_543
  - ( ) 1937713\_2013-09-13\_543
  - ( ) 1937713\_2013-11-23\_543
  - (S) 1937713\_2014-09-29\_543
  - ( ) 1937713\_2015-09-28\_543
  - ( ) 1937713\_tile
  - (M) 1937713\_2014-09-29\_W
  - ( ) 1937713\_2013-09-13\_W
  - ( ) 1937713\_2011-08-10\_W
  - ( ) 1937713\_2013-11-23\_W
  - ( ) 1937713\_2012-08-05\_W
  - ( ) 1937713\_2012-08-29\_W
  - ( ) 1937713\_2015-09-28\_W



Sintética  Texto

Principal Auxiliar Tela 2 Tela 3 Tela 4

PI: 1937713\_2014-09-29\_543

2014-09-29

SPRING-5.4.2 [Aguas][RioIca]

Arquivo Editar Exibir Imagem Temático MNT Cadastral Rede Análise SCarta Executar Ferramentas TerraLib Plugins Ajuda

Auto 1/ 19717.757812 Inativa ?

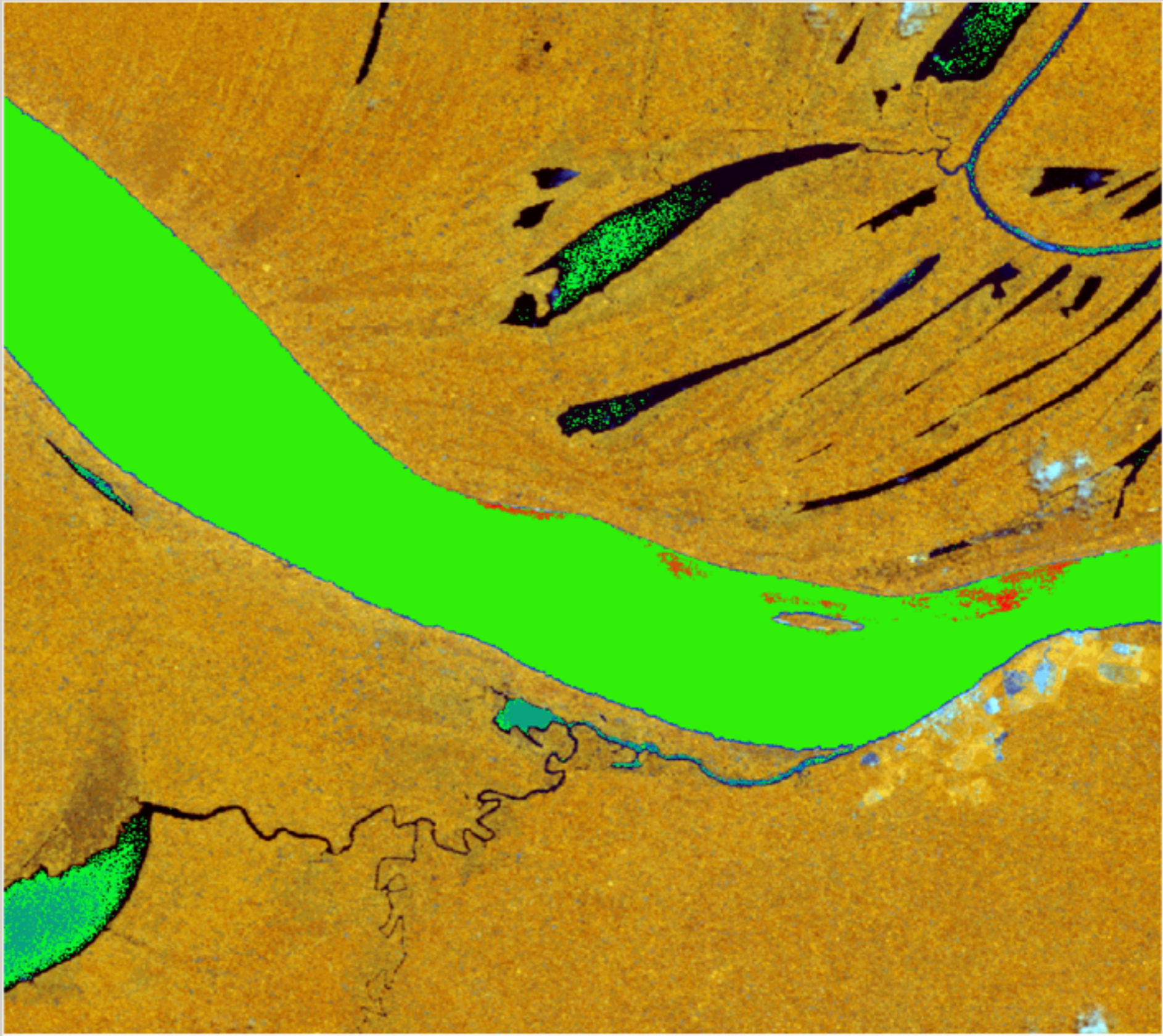
Painel de Controle

Tela Ativa : Auxiliar

PI Disponíveis | PI Seleccionados

Categoria / Plano de Informação

- ( ) CAT\_Cadastral
  - ( ) tile\_0
- (V) CAT\_Imagem
  - ( ) 1937713\_2011-08-10\_543
  - ( ) 1937713\_2012-08-05\_543
  - ( ) 1937713\_2012-08-29\_543
  - ( ) 1937713\_2013-09-13\_543
  - ( ) 1937713\_2013-11-23\_543
  - (S) 1937713\_2014-09-29\_543
  - ( ) 1937713\_2015-09-28\_543
  - ( ) 1937713\_tile
  - (M) 1937713\_2014-09-29\_W
  - ( ) 1937713\_2013-09-13\_W
  - ( ) 1937713\_2011-08-10\_W
  - ( ) 1937713\_2013-11-23\_W
  - ( ) 1937713\_2012-08-05\_W
  - ( ) 1937713\_2012-08-29\_W
  - ( ) 1937713\_2015-09-28\_W



Sintética  Texto

Principal Auxiliar Tela 2 Tela 3 Tela 4

PI: 1937713\_2014-09-29\_543

2015-09-08

SPRING-5.4.2 [Aguas][RioIca]

Arquivo Editar Exibir Imagem Temático MNT Cadastral Rede Análise SCarta Executar Ferramentas TerraLib Plugins Ajuda

Auto 1/ 88530.648438 Inativa ?

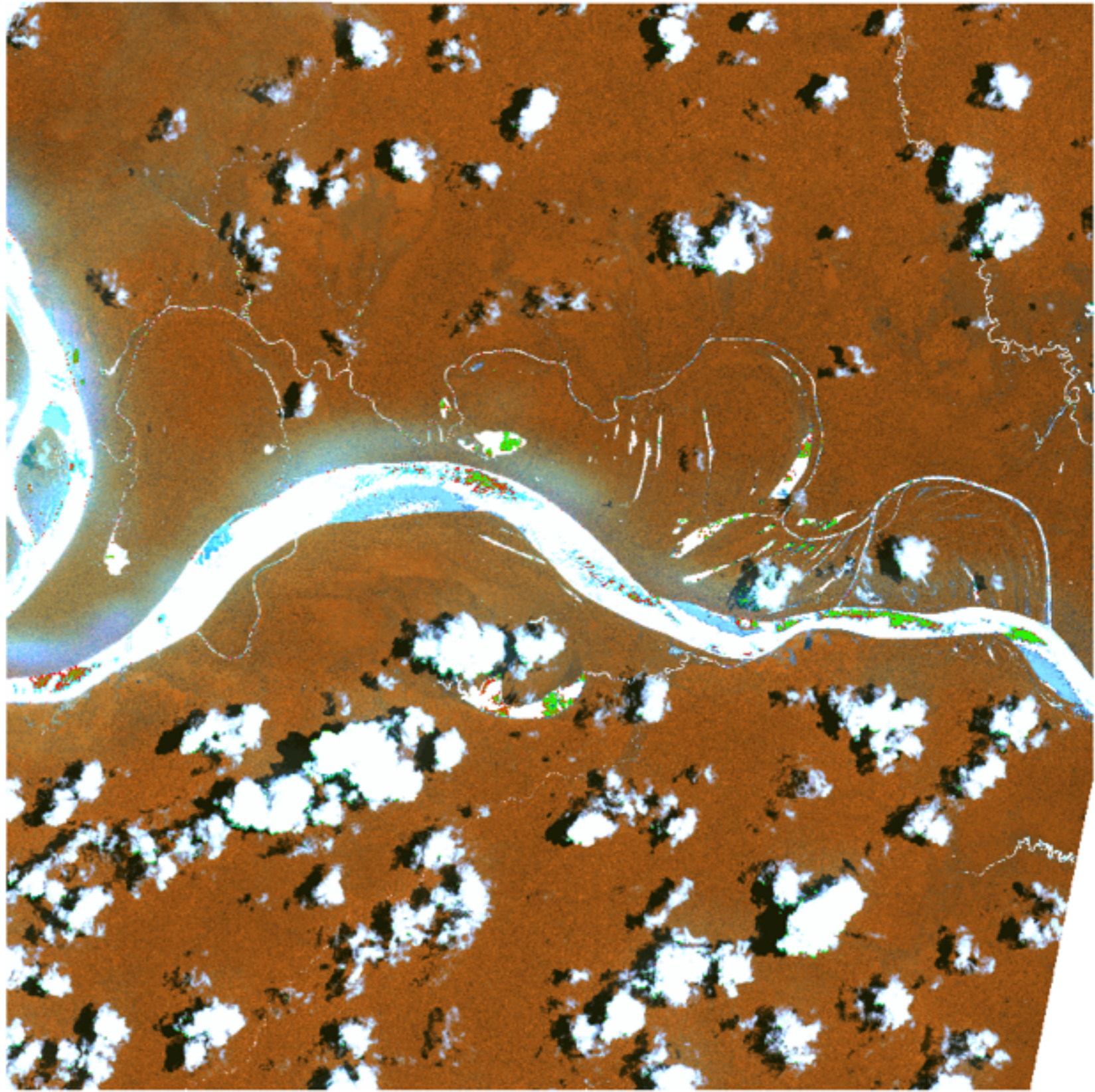
Painel de Controle

Tela Ativa : Auxiliar

PI Disponíveis | PI Selecionados

Categoria / Plano de Informação

- CAT\_Cadastral
  - tile\_0
- CAT\_Imagem
  - 1937713\_2011-08-10\_543
  - 1937713\_2012-08-05\_543
  - 1937713\_2012-08-29\_543
  - 1937713\_2013-09-13\_543
  - 1937713\_2013-11-23\_543
  - 1937713\_2014-09-29\_543
  - 1937713\_2015-09-28\_543
  - 1937713\_tile
  - 1937713\_2014-09-29\_W
  - 1937713\_2013-09-13\_W
  - 1937713\_2011-08-10\_W
  - 1937713\_2013-11-23\_W
  - 1937713\_2012-08-05\_W
  - 1937713\_2012-08-29\_W
  - 1937713\_2015-09-28\_W



M  Texto  
 R  G  B

Principal Auxiliar Tela 2 Tela 3 Tela 4

PI: 1937713\_2015-09-28\_W

2015-09-08

SPRING-5.4.2 [Aguas][RioIca]

Arquivo Editar Exibir Imagem Temático MNT Cadastral Rede Análise SCarta Executar Ferramentas TerraLib Plugins Ajuda

Auto 1/ 14827.041016 Inativa ?

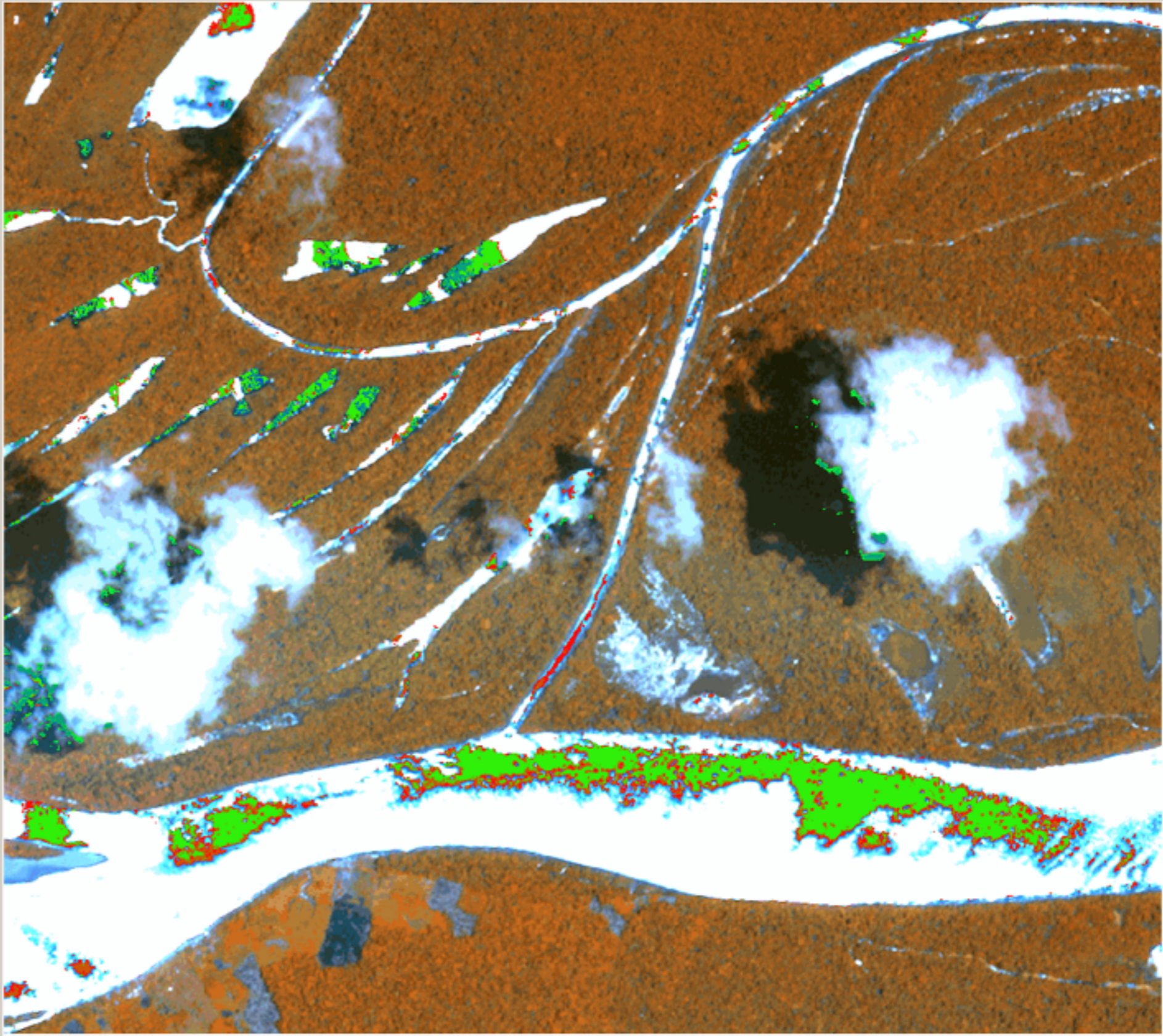
Painel de Controle

Tela Ativa : Auxiliar

PI Disponíveis | PI Selecionados

Categoria / Plano de Informação

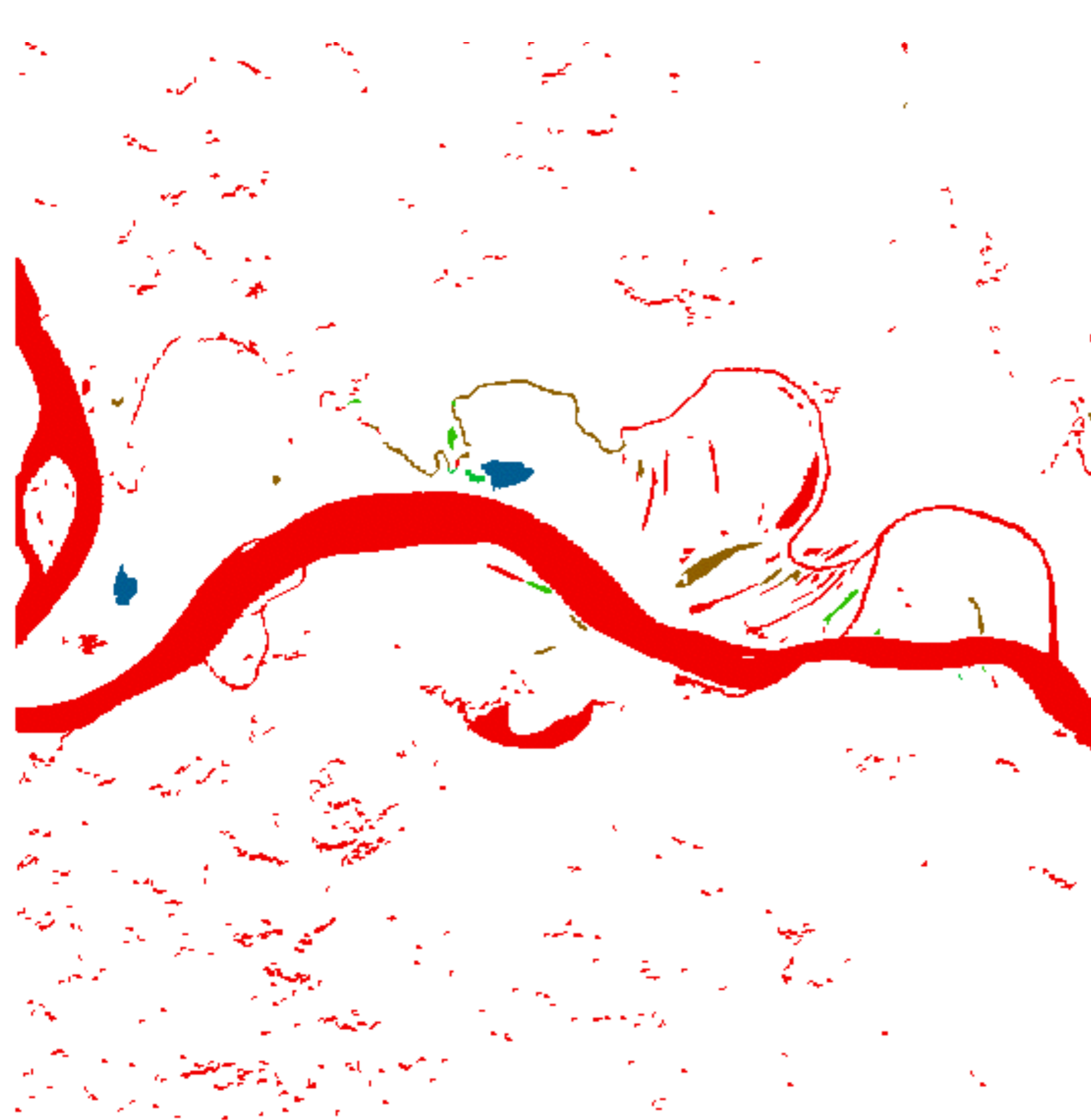
- CAT\_Cadastral
  - tile\_0
- CAT\_Imagem
  - 1937713\_2011-08-10\_543
  - 1937713\_2012-08-05\_543
  - 1937713\_2012-08-29\_543
  - 1937713\_2013-09-13\_543
  - 1937713\_2013-11-23\_543
  - 1937713\_2014-09-29\_543
  - 1937713\_2015-09-28\_543
  - 1937713\_tile
  - 1937713\_2014-09-29\_W
  - 1937713\_2013-09-13\_W
  - 1937713\_2011-08-10\_W
  - 1937713\_2013-11-23\_W
  - 1937713\_2012-08-05\_W
  - 1937713\_2012-08-29\_W
  - 1937713\_2015-09-28\_W



M  Texto  
 R  G  B

Principal Auxiliar Tela 2 Tela 3 Tela 4

PI: 1937713\_2015-09-28\_W

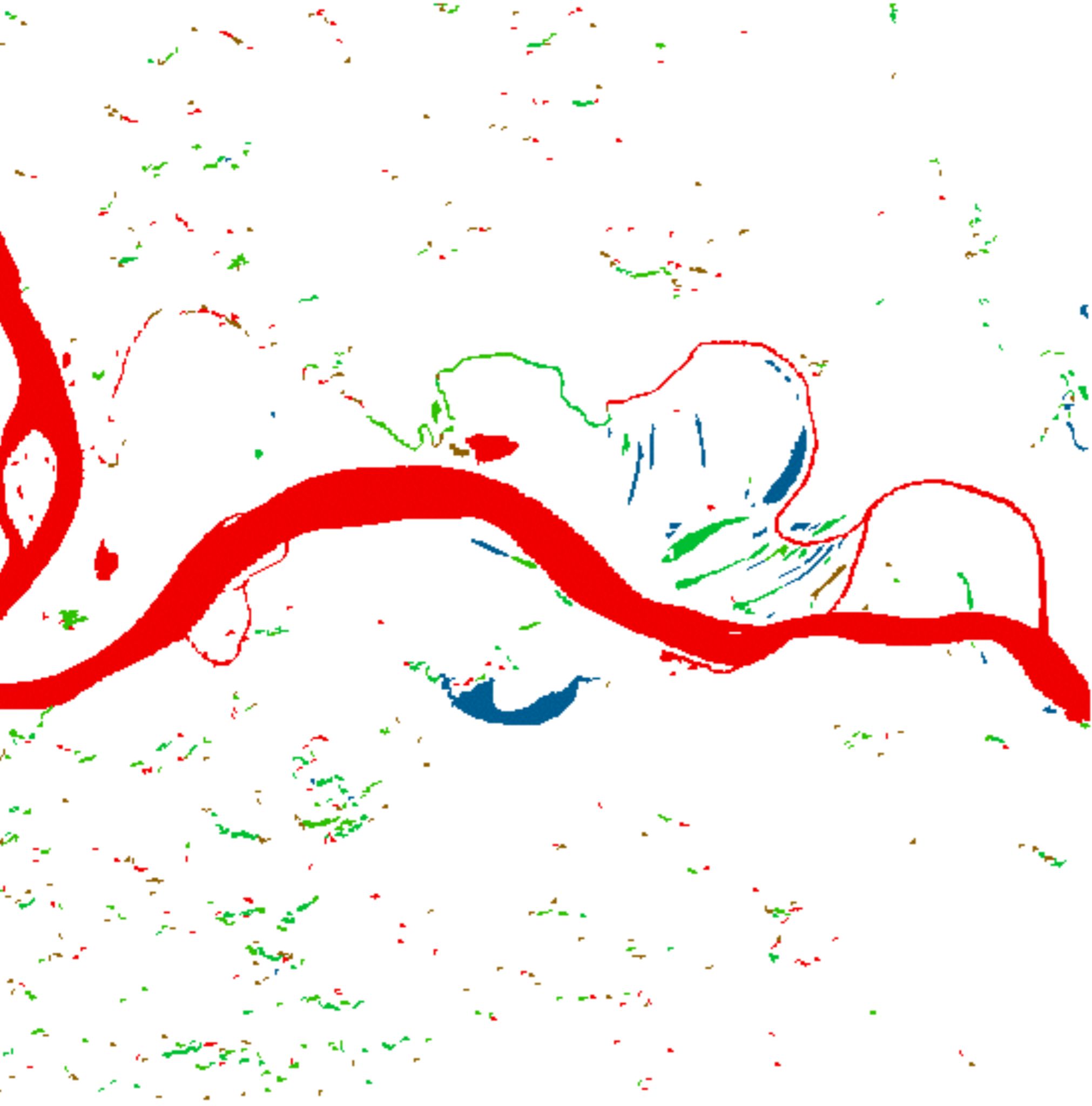


Visualização de Objetos

tile\_0\_0

GROUP: CG000021->CLASS\_1 / NONE

		+	[0.0000 ~ 0.1866]
		+	>0.1866 ~ 0.3733]
		+	>0.3733 ~ 0.5599]
		+	>0.5599 ~ 0.7465]
		+	>0.7465 ~ 0.9332]

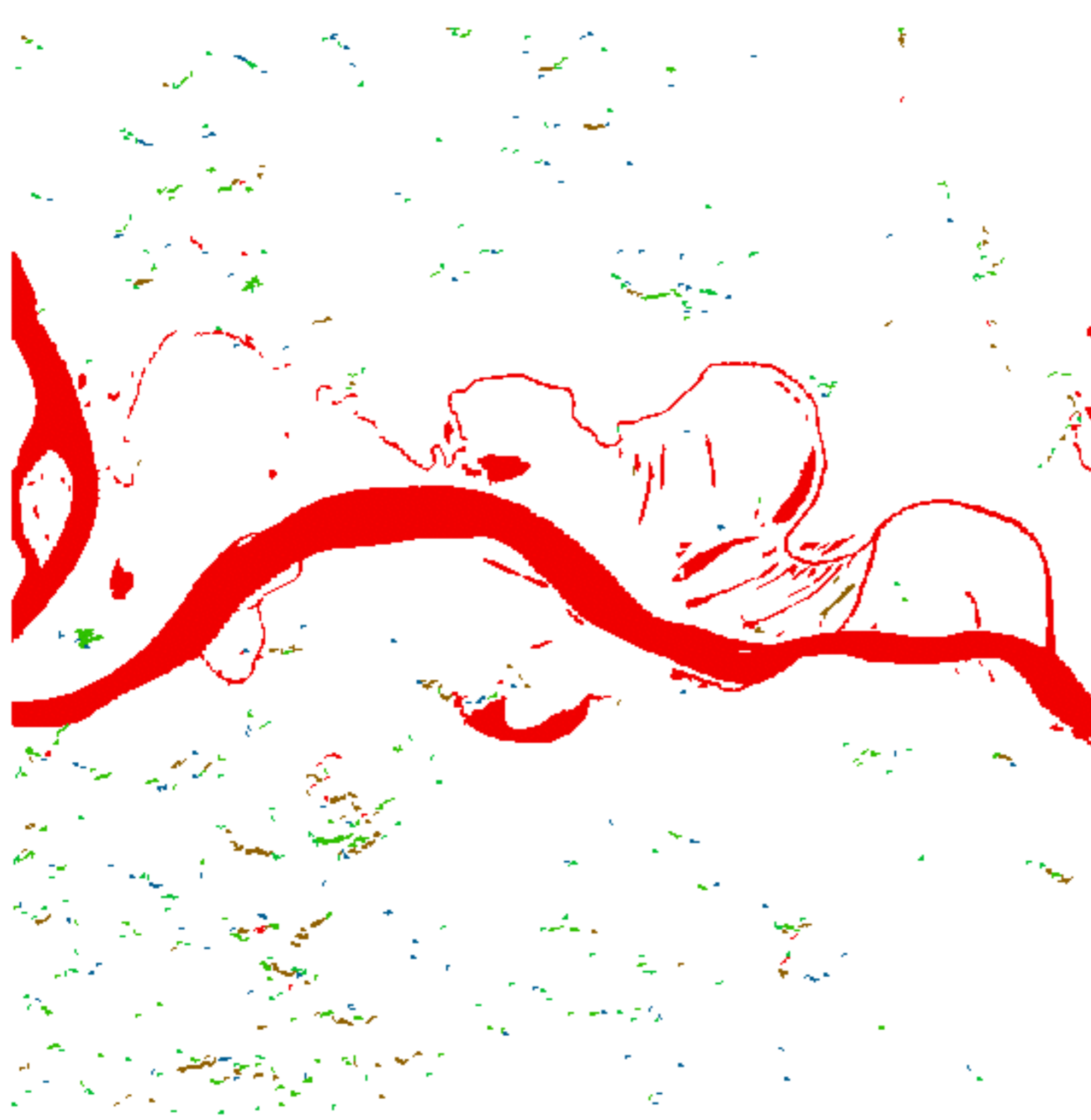


Visualização de Objetos

tile\_0\_0

GROUP: CG000021->CLASS\_2 / NONE

		+	[0.0000 ~ 0.2000]
		+	>0.2000 ~ 0.4000]
		+	>0.4000 ~ 0.6000]
		+	>0.6000 ~ 0.8000]
		+	>0.8000 ~ 1.0000]



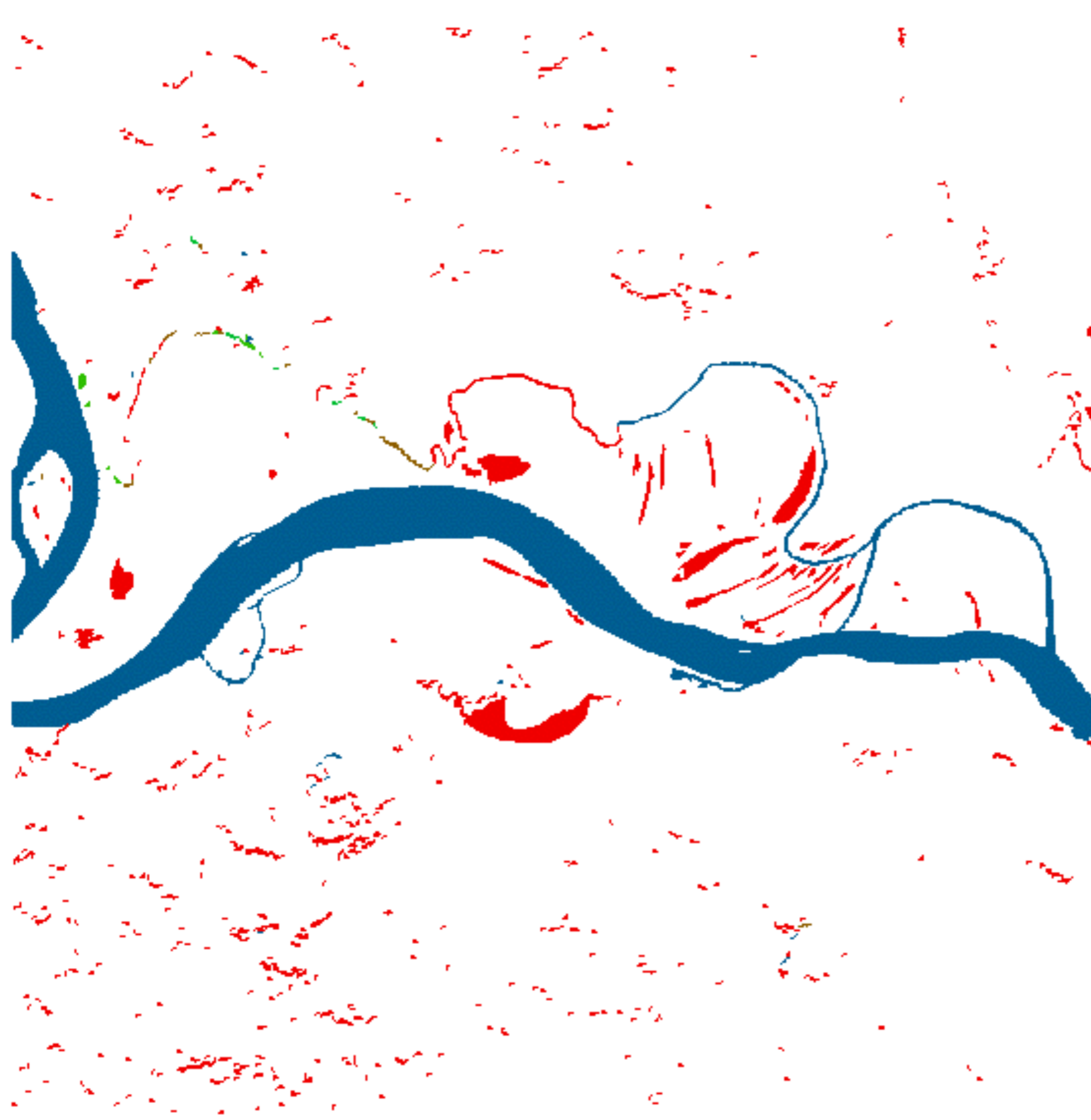
Visualização de Objetos

tile\_0\_0

GROUP: CG000021->CLASS\_3 / NONE

		+	[0.0000 ~ 0.2000]
		+	>0.2000 ~ 0.4000]
		+	>0.4000 ~ 0.6000]
		+	>0.6000 ~ 0.8000]
		+	>0.8000 ~ 1.0000]



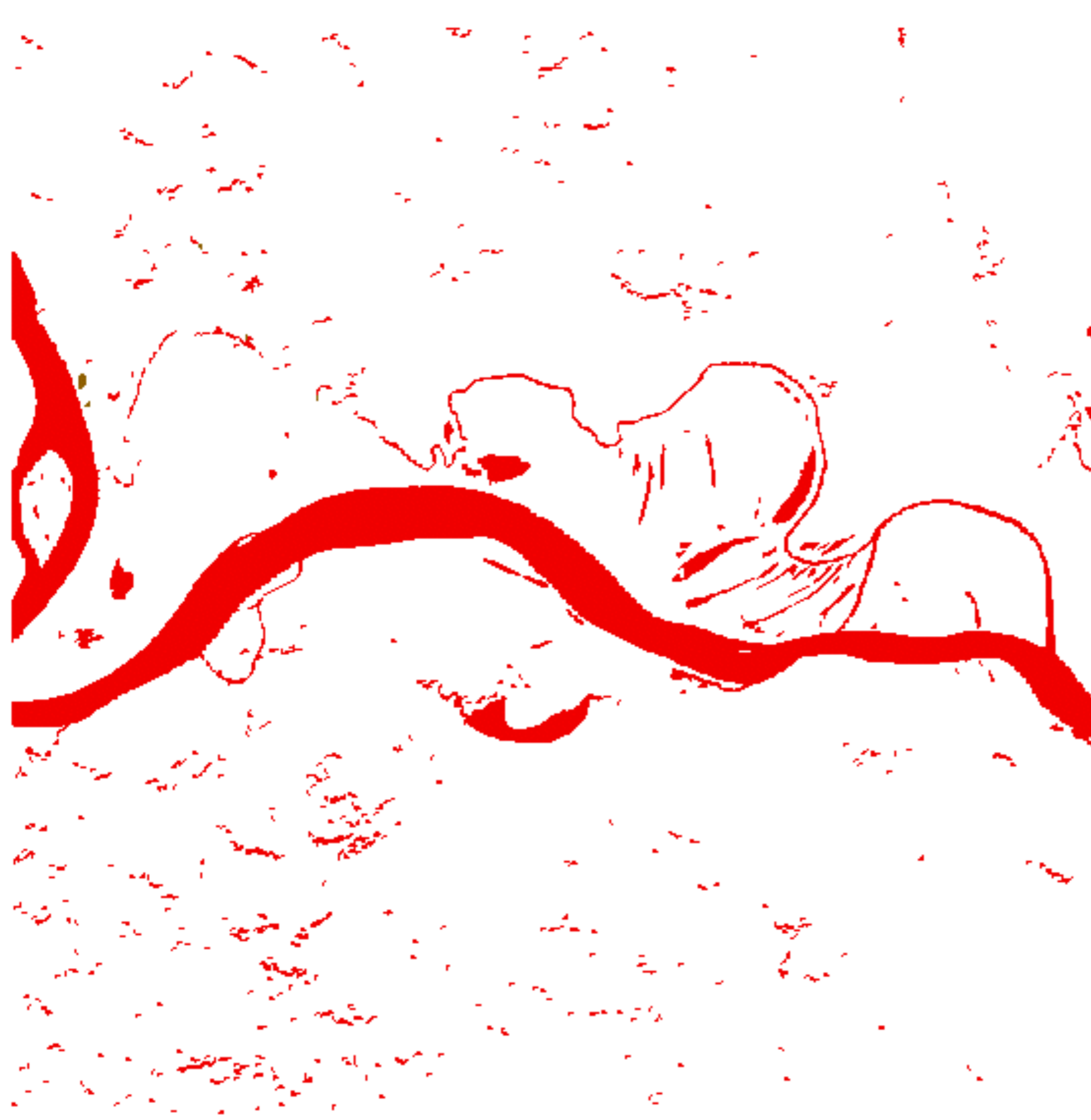


Visualização de Objetos

tile\_0\_0

GROUP: CG000021->CLASS\_4 / NONE

		+	[0.0000 ~ 0.2000]
		+	>0.2000 ~ 0.4000]
		+	>0.4000 ~ 0.6000]
		+	>0.6000 ~ 0.8000]
		+	>0.8000 ~ 1.0000]

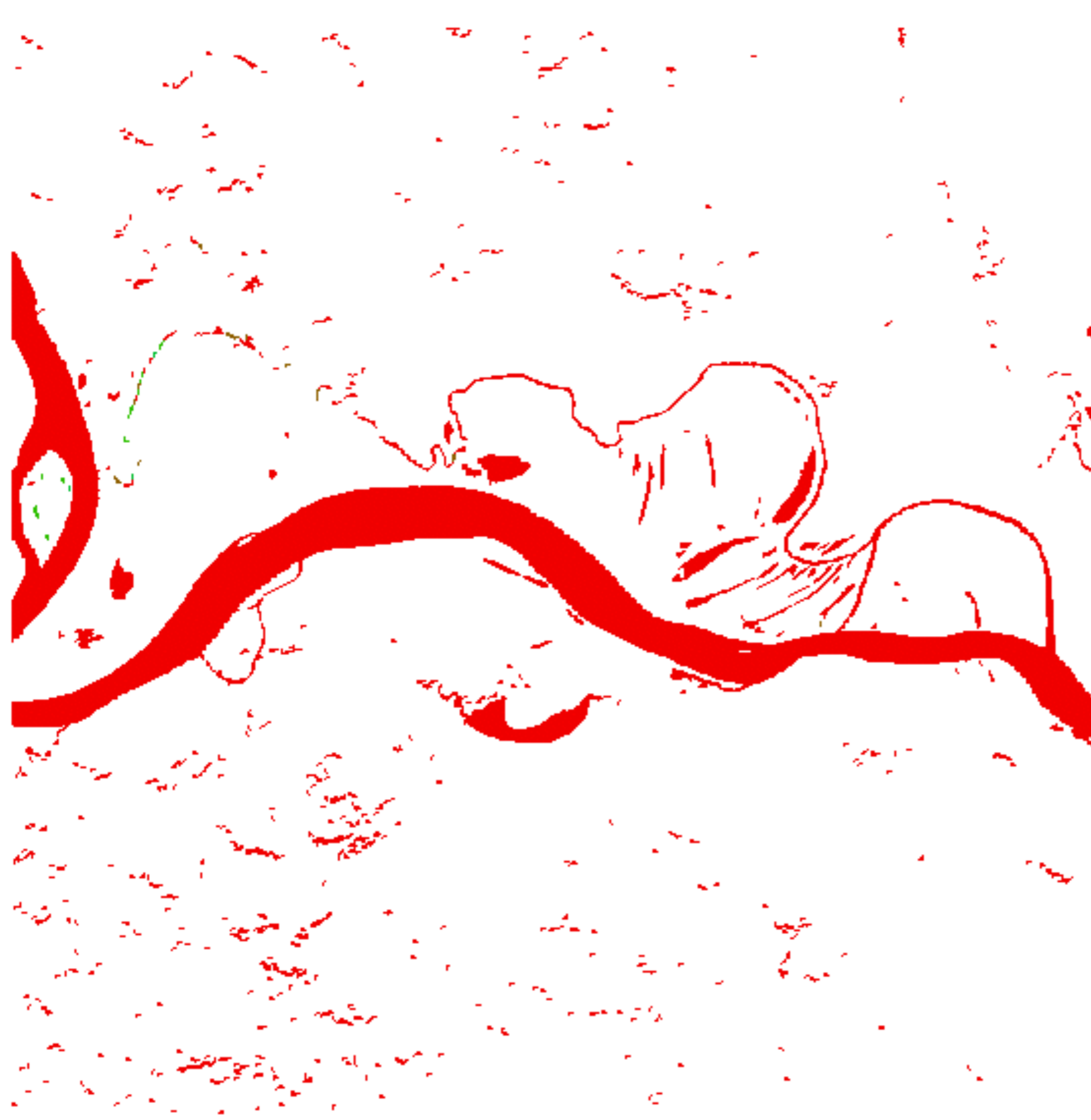


**Visualização de Objetos**


tile\_0\_0

GROUP: CG000021->CLASS\_5 / NONE

		+	[0.0000 ~ 0.2000]
		+	>0.2000 ~ 0.4000]
		+	>0.4000 ~ 0.6000]
		+	>0.6000 ~ 0.8000]
		+	>0.8000 ~ 1.0000]













Visualização de Objetos




tile\_0\_0

GROUP: CG000021->CLASS\_6 / NONE

		+	[0.0000 ~ 0.2000]
		+	>0.2000 ~ 0.4000]
		+	>0.4000 ~ 0.6000]
		+	>0.6000 ~ 0.8000]
		+	>0.8000 ~ 1.0000]







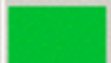





Visualização de Objetos



tile\_0\_0

GROUP: CG000021->CLASS\_7 / NONE

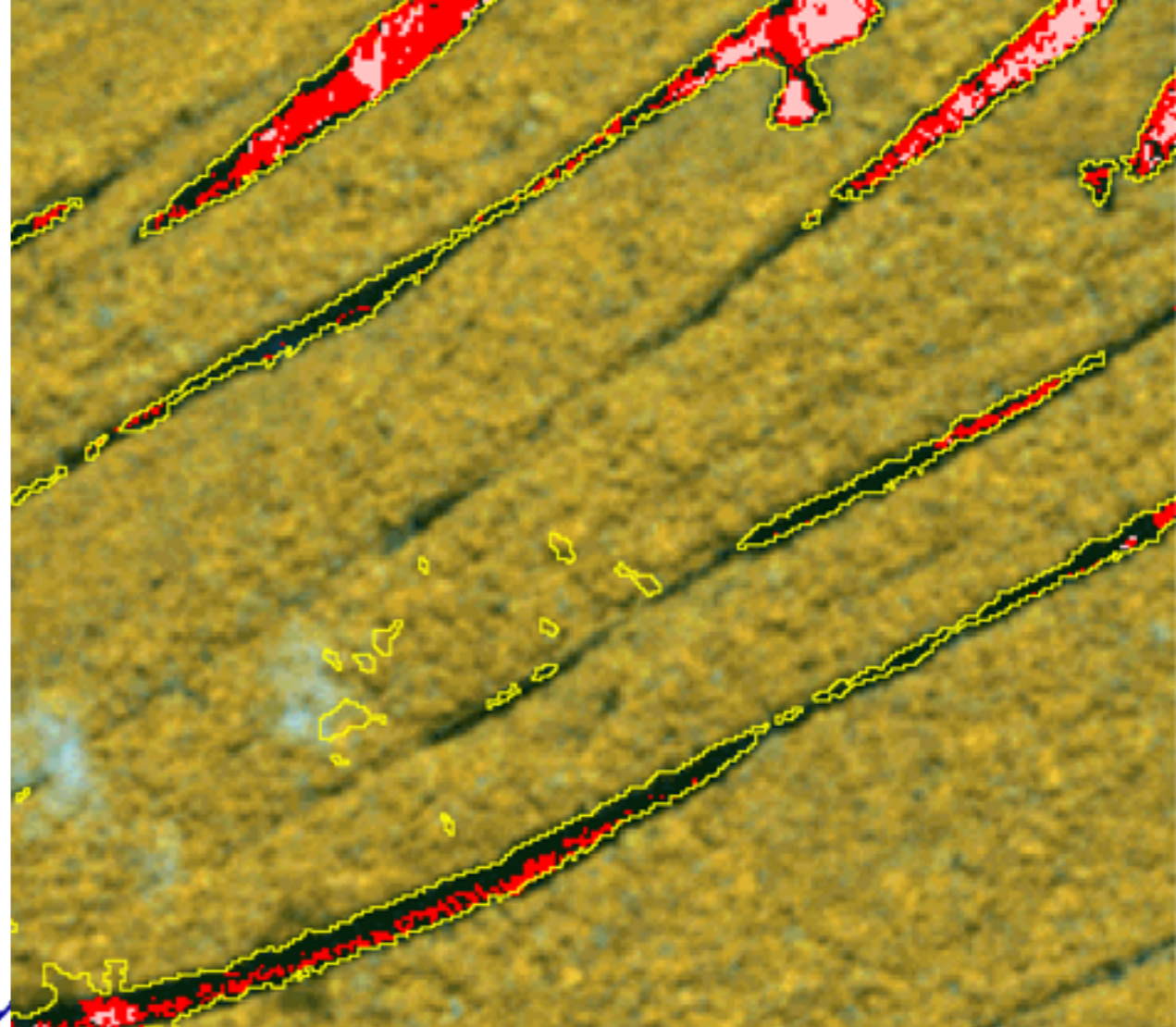
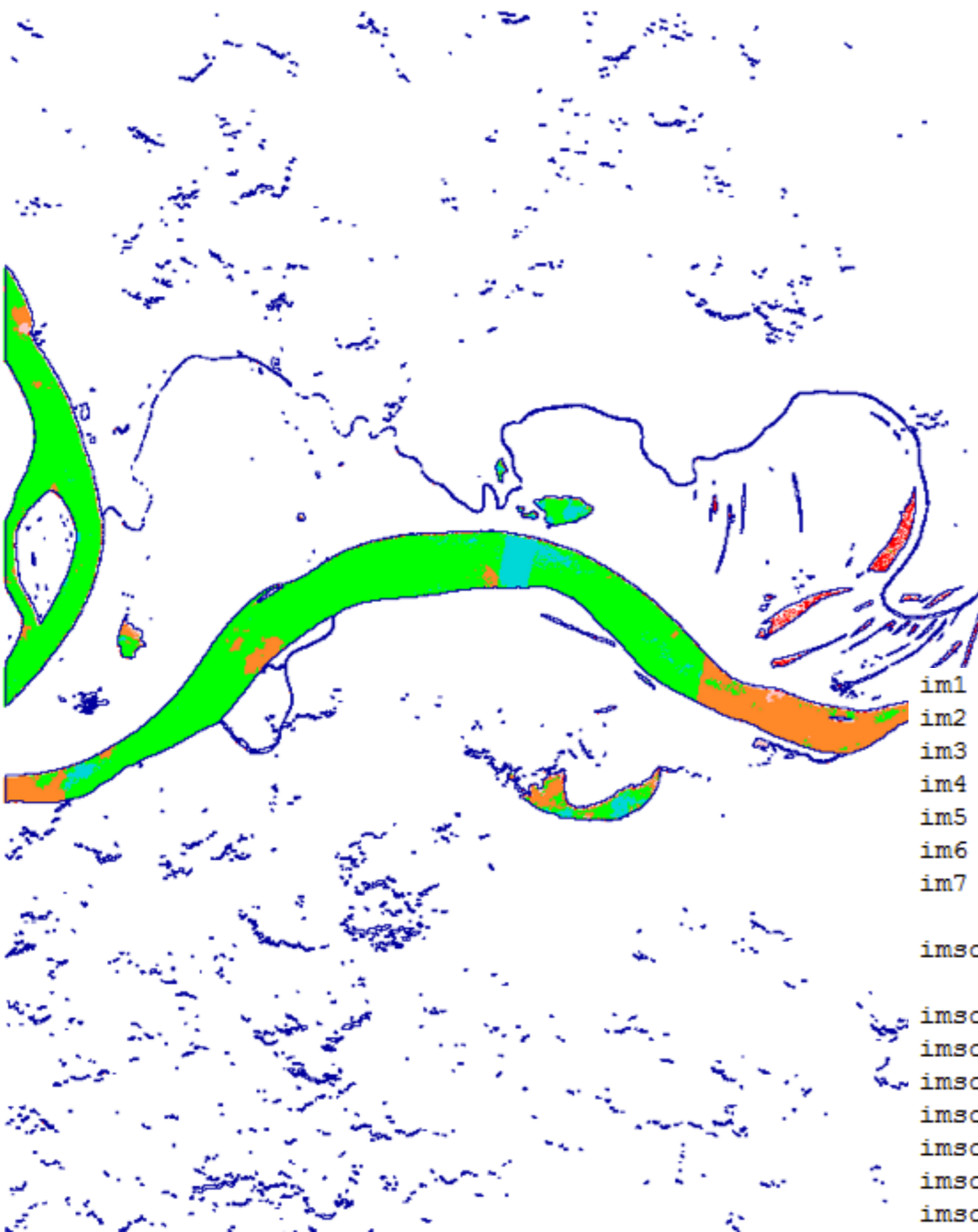
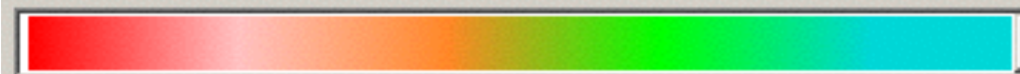
		+	[0.0000 ~ 0.2000]
		+	>0.2000 ~ 0.4000]
		+	>0.4000 ~ 0.6000]
		+	>0.6000 ~ 0.8000]
		+	>0.8000 ~ 1.0000]

Mínimo:

2

Máximo:

7



```
im1 = Recuperar( Nome = "1937713_2011-08-10_W" );
im2 = Recuperar( Nome = "1937713_2012-08-05_W" );
im3 = Recuperar( Nome = "1937713_2012-08-29_W" );
im4 = Recuperar( Nome = "1937713_2013-09-13_W" );
im5 = Recuperar( Nome = "1937713_2013-11-23_W" );
im6 = Recuperar( Nome = "1937713_2014-09-29_W" );
im7 = Recuperar( Nome = "1937713_2015-09-28_W" );

imsom = Novo( Nome = "Conta", ResX = 5 , ResY = 5 );

imsom = (im1 > 0 && im1 < 10) ? 1 : 0;
imsom = (im2 > 0 && im2 < 10) ? 1 + imsom : imsom;
imsom = (im3 > 0 && im3 < 10) ? 1 + imsom : imsom;
imsom = (im4 > 0 && im4 < 10) ? 1 + imsom : imsom;
imsom = (im5 > 0 && im5 < 10) ? 1 + imsom : imsom;
imsom = (im6 > 0 && im6 < 10) ? 1 + imsom : imsom;
imsom = (im7 > 0 && im7 < 10) ? 1 + imsom : imsom;
```

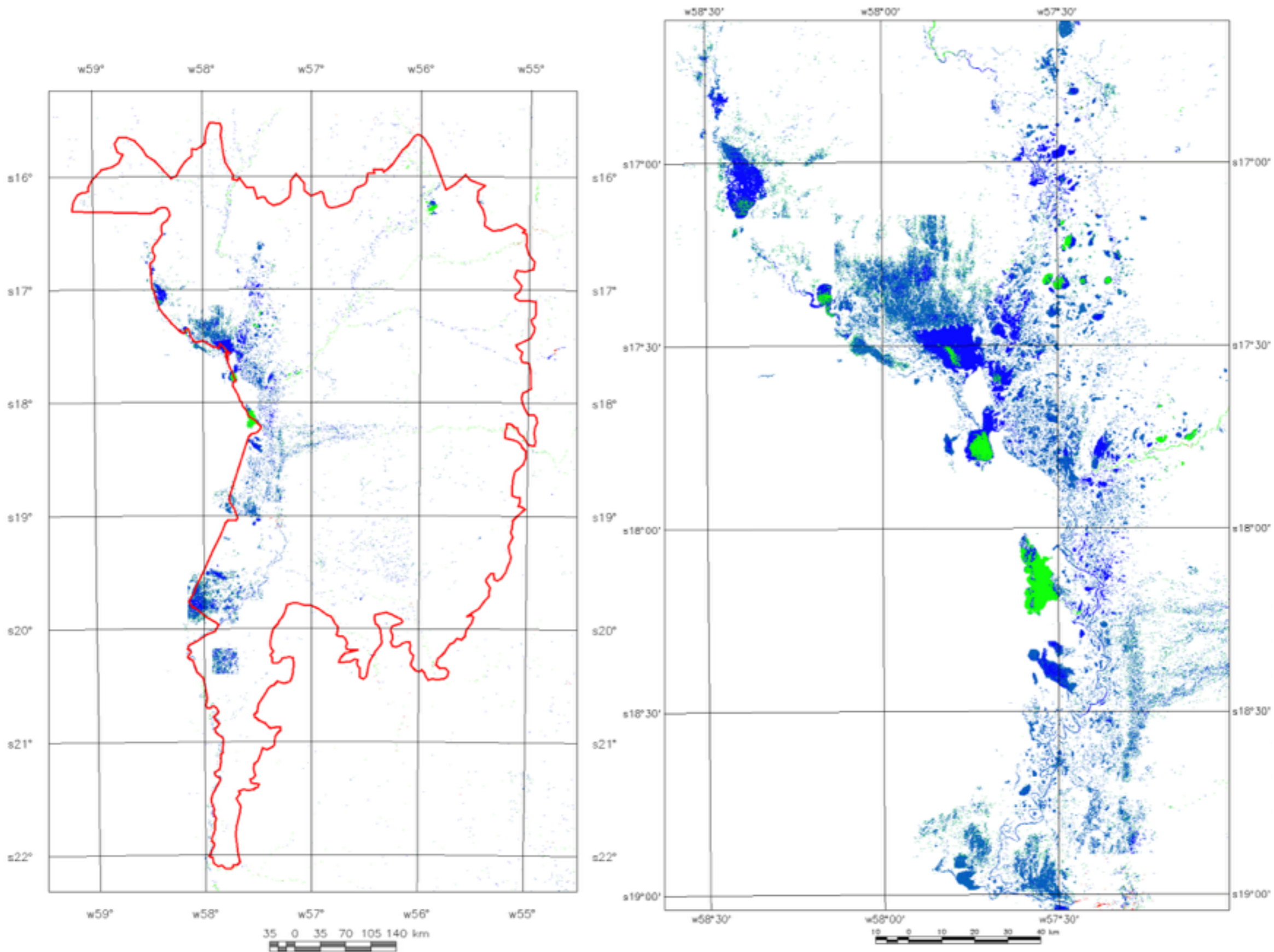
# Aplicações

Mapeamento

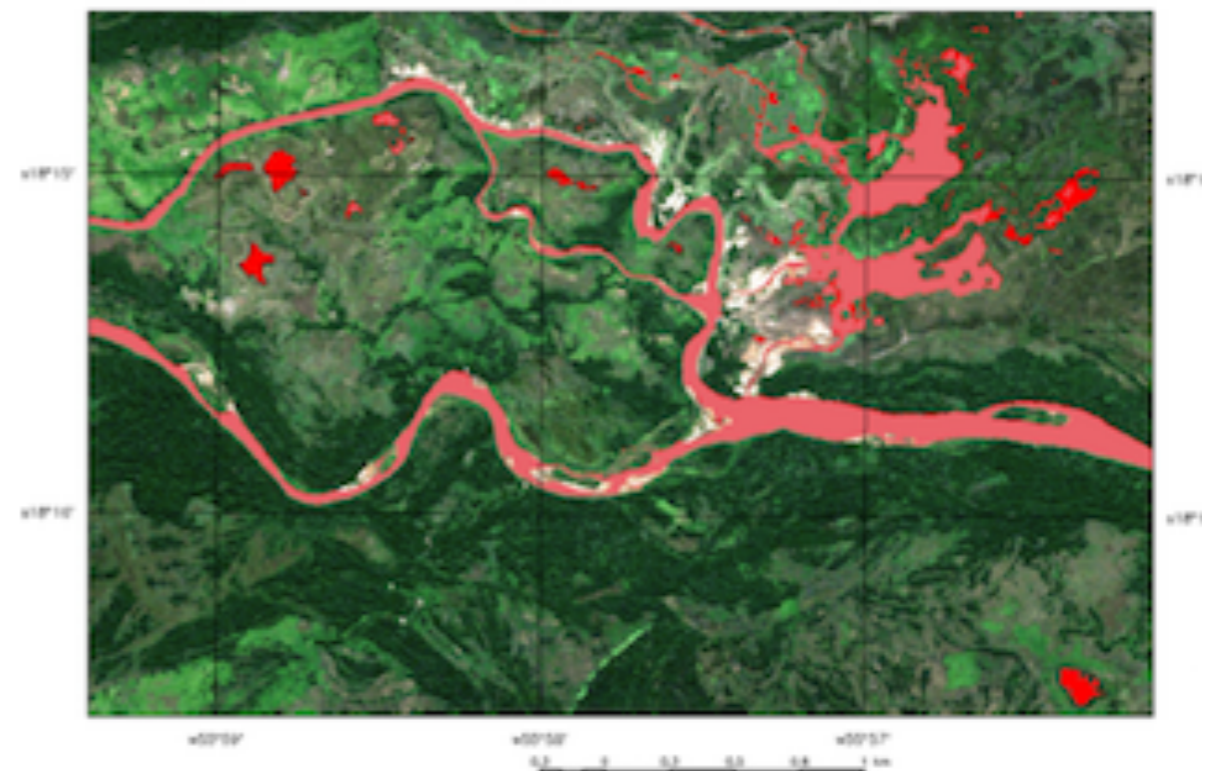
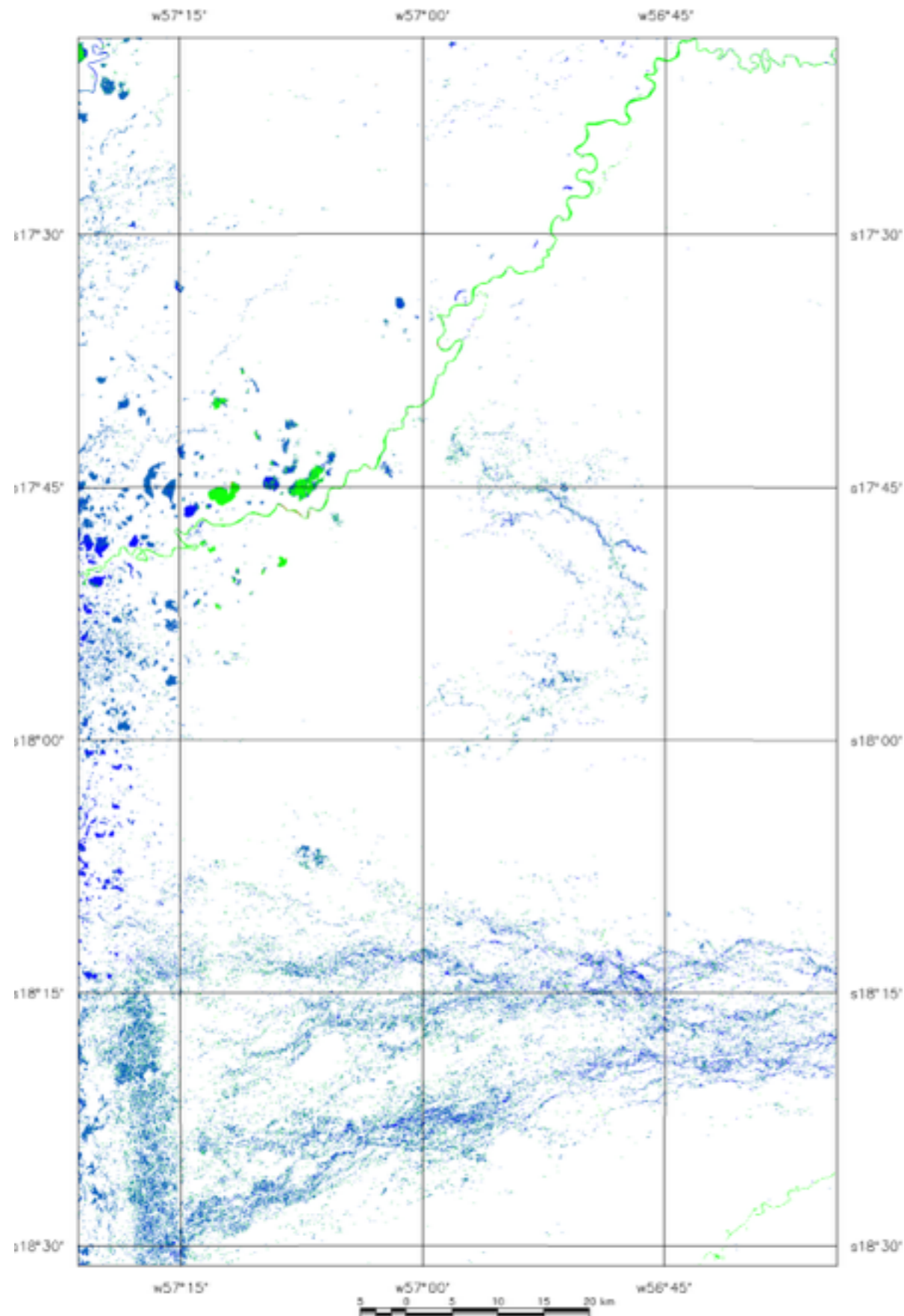
Monitoramento

Desastres

# Pantanal



# Pantanal





# Barragem de Lagoa de Mineração - Jacareí/SP 5/Fev/2016



Foto: Reprodução/TV Vanguarda



"O vazamento provocou desabastecimento de água a 75% a população de São José dos Campos (SP). A Sabesp informou a tarde que retomou a captação, mas o serviço só deve ser normalizado neste domingo (7)" - <http://g1.globo.com/sp/vale-do-paraiba-regiao/noticia>

# Monitoramento

Disponibilidade de imagens de satélite:

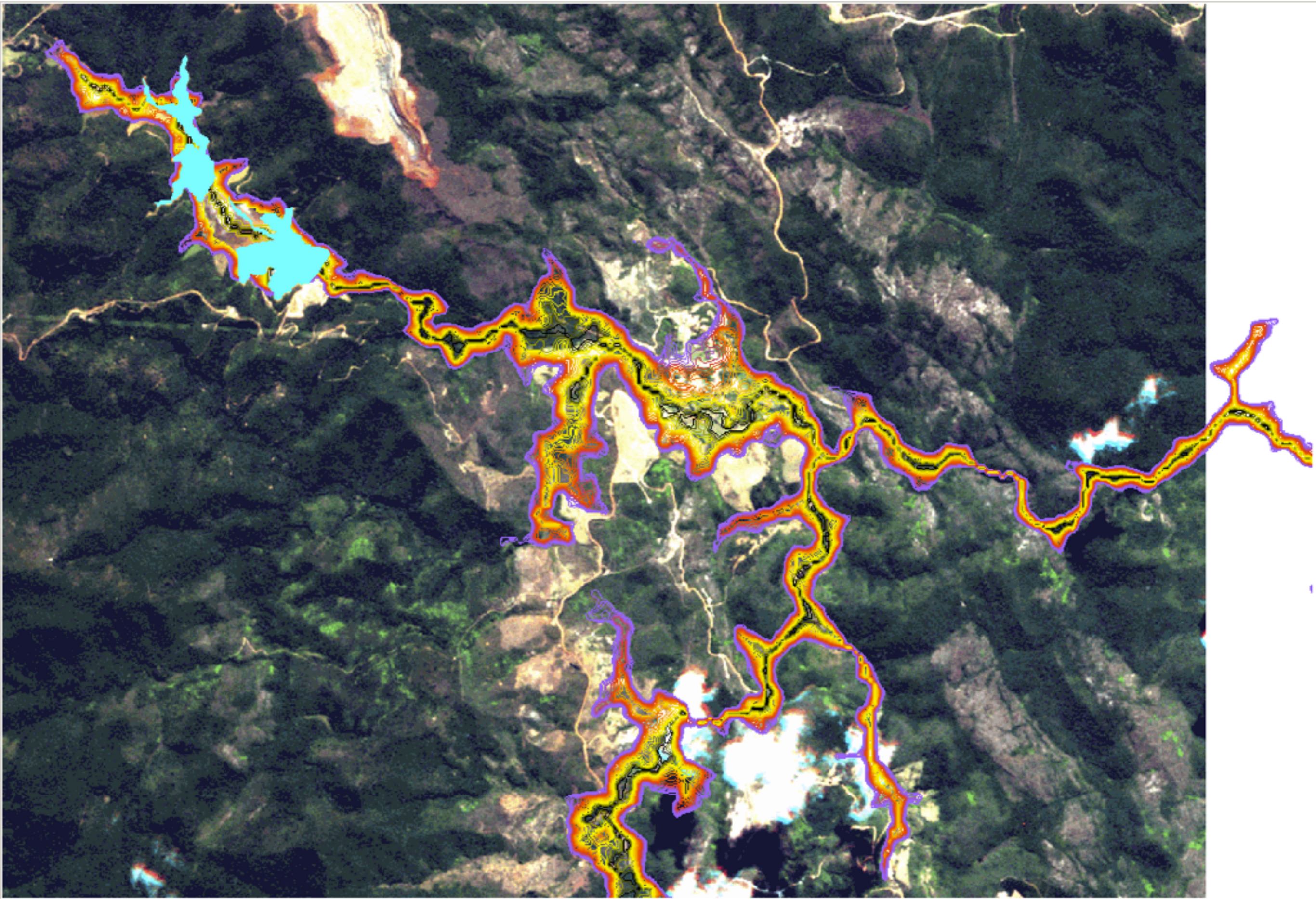
CBERS4

Landsat8

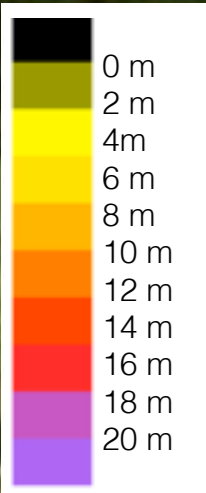
Sentinel

ResourceSat

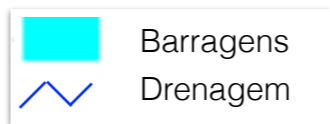
Isolinhas do HAND de 0 a 20 metros (a cada 2 metros)



# Itabira-MG



**1 Km**

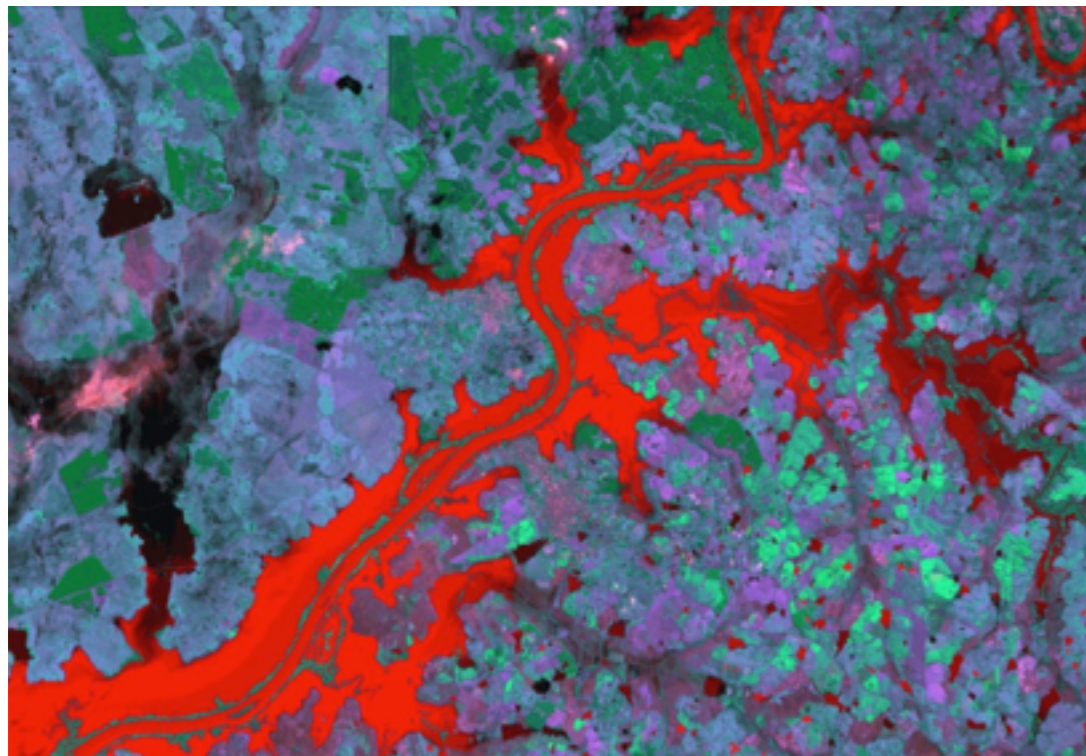


# Inundação -São Borja/RS

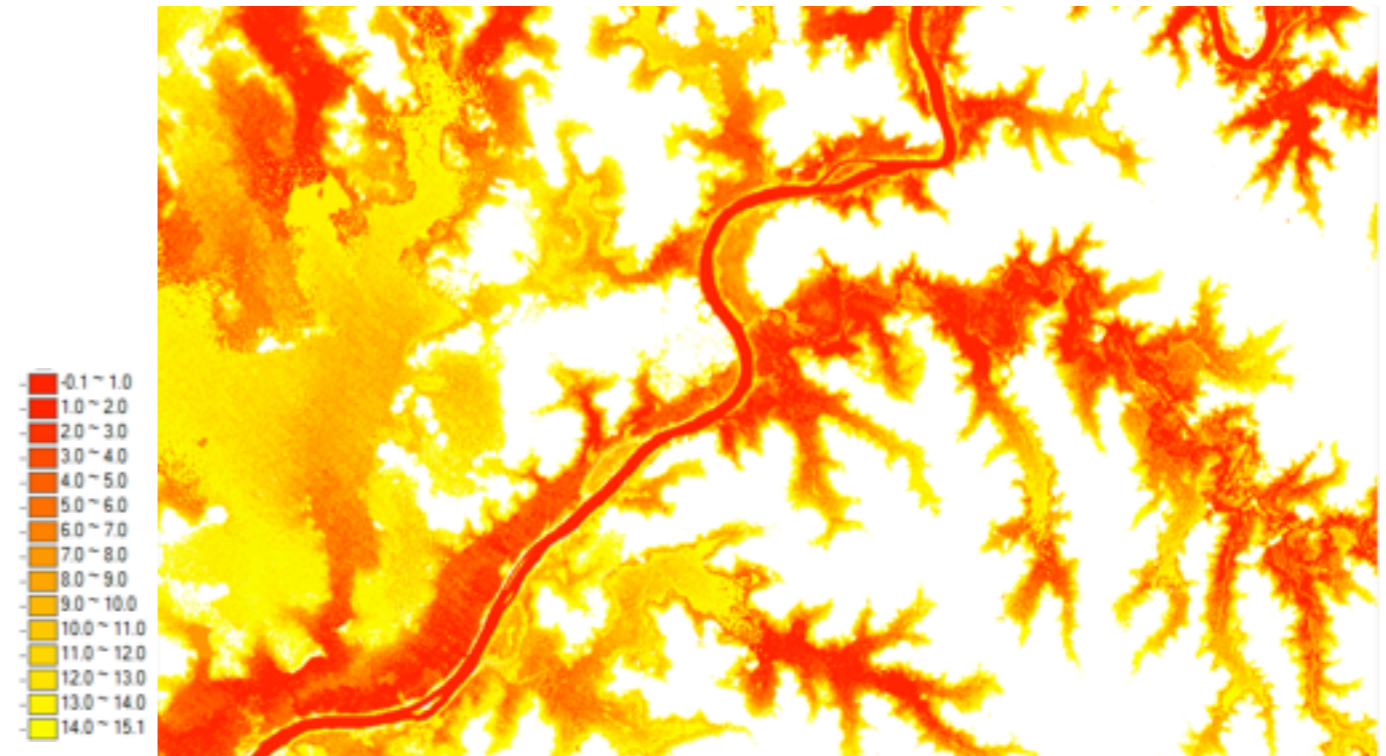
## Julho/2014

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[Pesquisar Dados](#) | [Exportar Dados](#)

ORIGEM	BACIA	SUBBACIA	ESTAÇÃO
<todos>	4 Rio São Francisco	72 RIOS URUGUAI, DO PEIXE E OUTROS	75900000 ITAQUI
ANA/INPE	5 Atlântico, Trecho Leste	73 RIOS URUGUAI, CHAPECO E OUTROS	75500000 PASSO DO SARMENTO
ANA/SIVAM	6 Rio Paraná	74 RIOS URUGUAI, DA VARZEA E ....	75780000 PASSO SÃO BORJA
RES. CONJ. 03	7 Rio Uruquai	75 RIOS URUGUAI, IJUI E OUTROS	75780000 PASSO SÃO BORJA
	PASSO SÃO BORJA	05/07/2014 07:00:00	1470
	PASSO SÃO BORJA	05/07/2014 17:00:00	1316
	PASSO SÃO BORJA	05/07/2014 07:00:00	1356
	PASSO SÃO BORJA	04/07/2014 17:00:00	1434
	PASSO SÃO BORJA	04/07/2014 07:00:00	1476
	PASSO SÃO BORJA	03/07/2014 17:00:00	1534
	PASSO SÃO BORJA	03/07/2014 07:00:00	1563
	PASSO SÃO BORJA	02/07/2014 17:00:00	1586
	PASSO SÃO BORJA	02/07/2014 07:00:00	1588
	PASSO SÃO BORJA	01/07/2014 17:00:00	1564

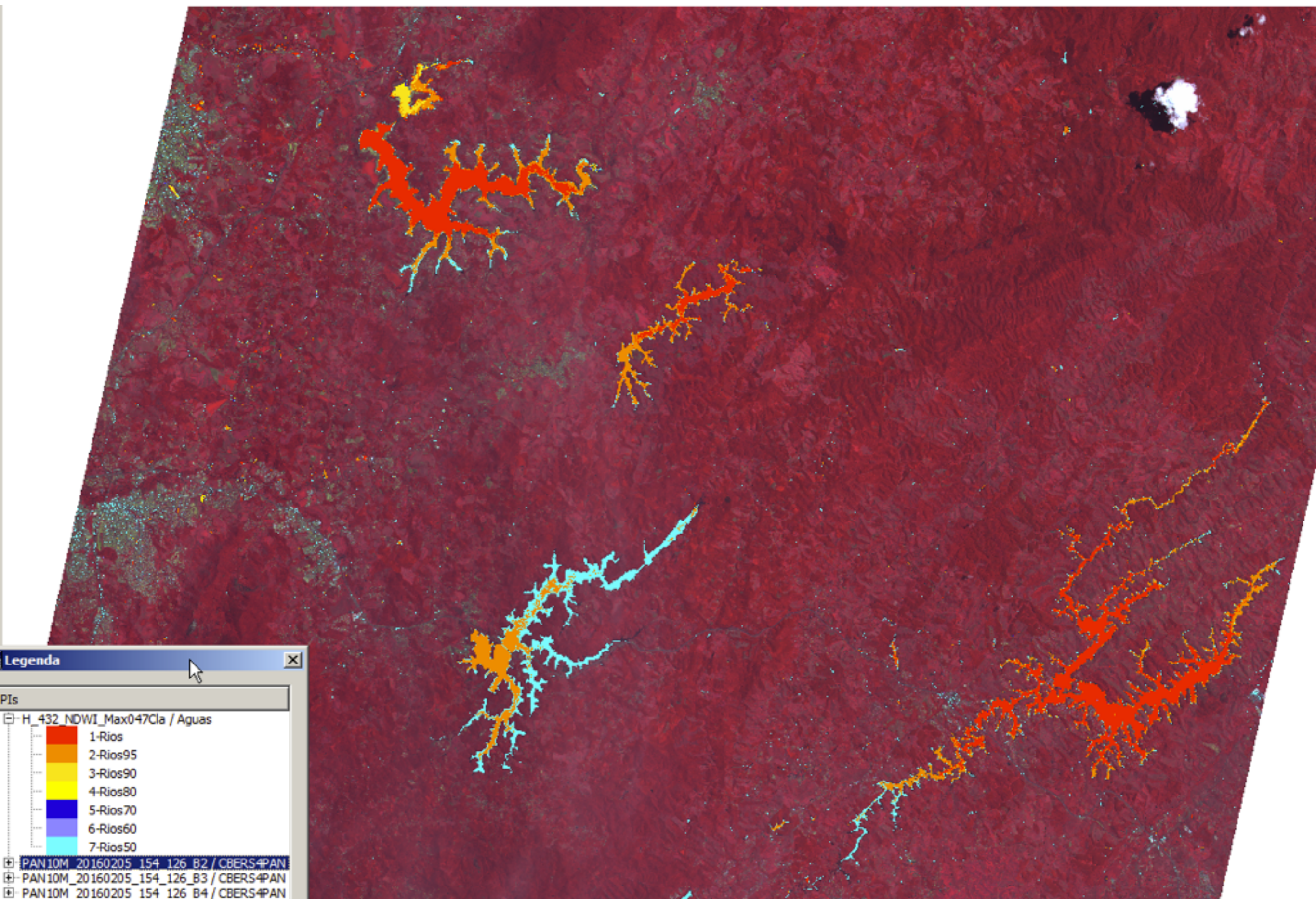


Landsat 8 - 5/Jul/2014  
 Passo São Borja/RS  
 13,56 m (07:00h)

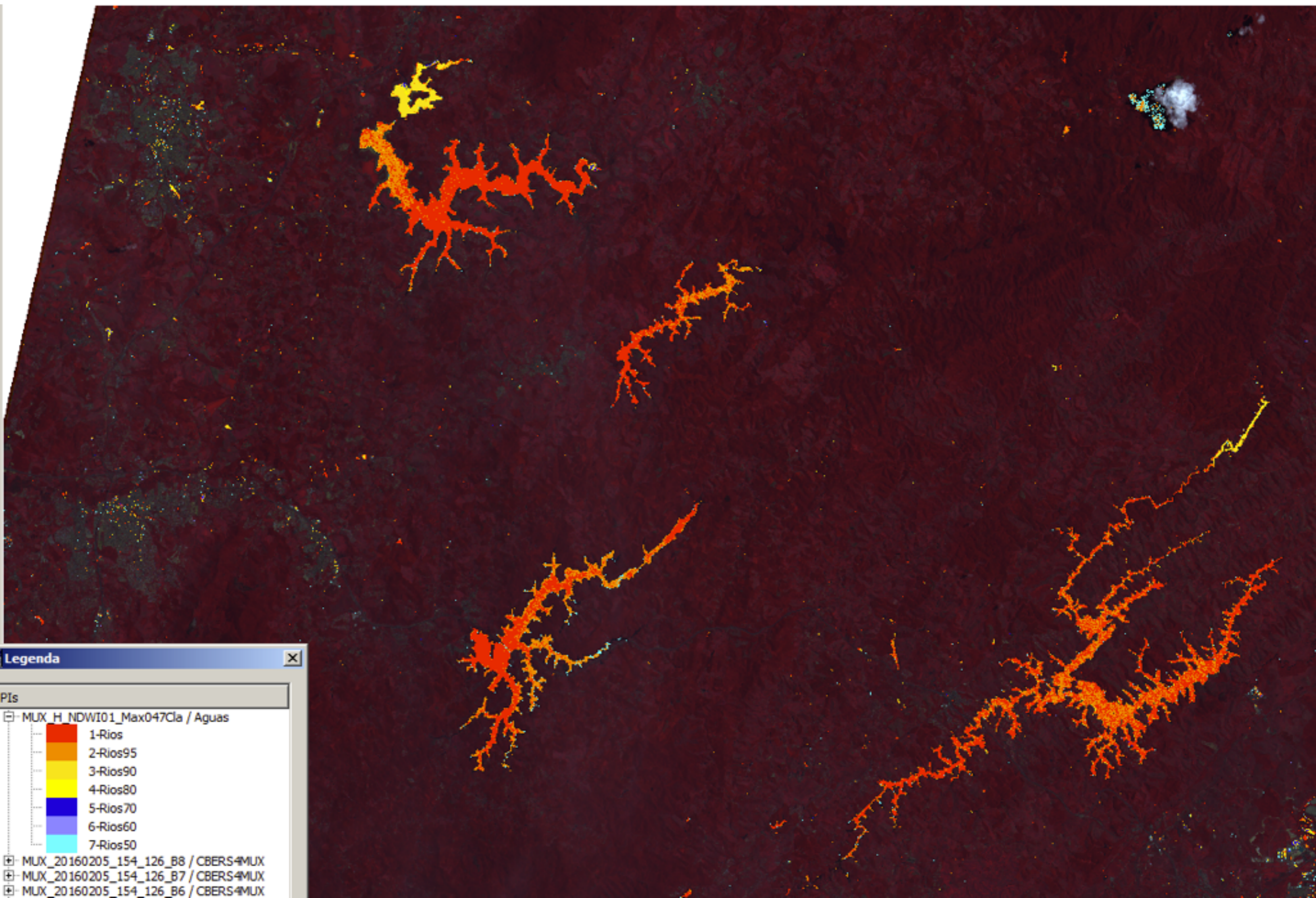


Máximo (3/Jul/2014):  
 15,88 m (07:00h) - HAND  
 Inundação simulada (SRTM 90m)

# Detecção de Lâmina de Água em CBERS4-PAN



# Detecção de Lâmina de Água em CBERS4-MUX



**Legenda**

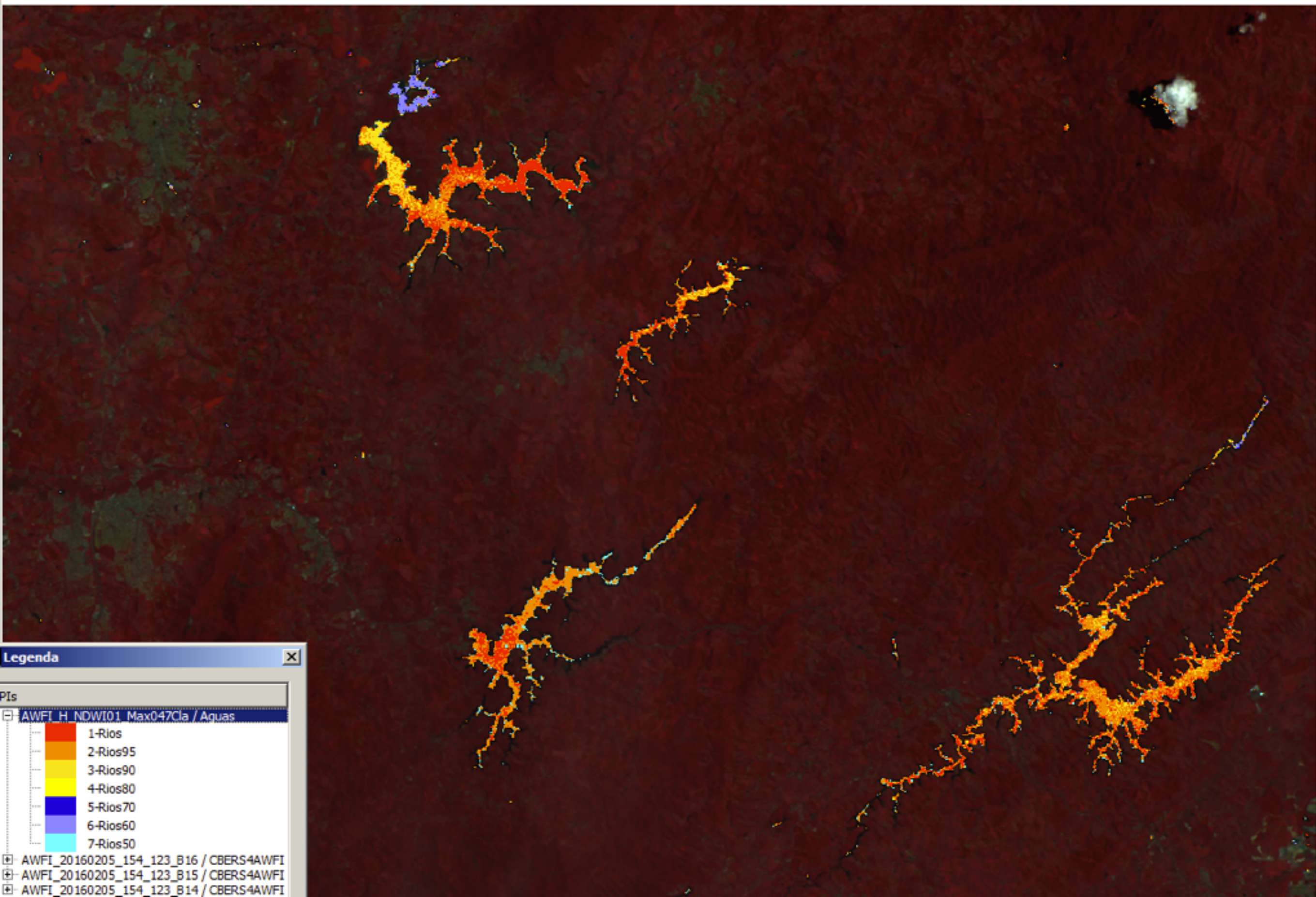
PIs

MUX\_H NDWI01\_Max047Cla / Aguas

- 1-Rios
- 2-Rios95
- 3-Rios90
- 4-Rios80
- 5-Rios70
- 6-Rios60
- 7-Rios50

MUX\_20160205\_154\_126\_B8 / CBERS4MUX  
MUX\_20160205\_154\_126\_B7 / CBERS4MUX  
MUX\_20160205\_154\_126\_B6 / CBERS4MUX

# Detecção de Lâmina de Água em CBERS4-AWFI





# Plataforma Para Monitoramento

