

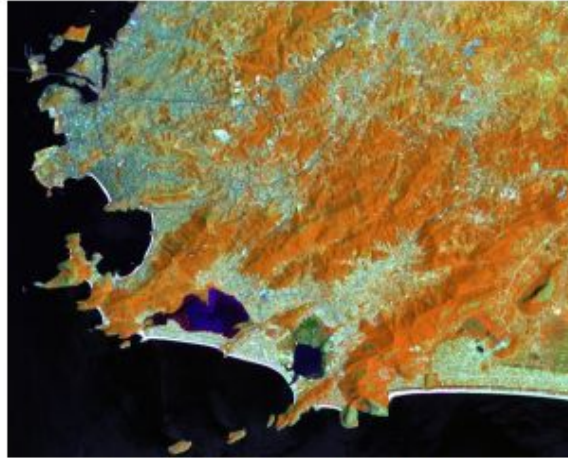
Aula 4 - Processamento Digital de Imagens (22/09/2023)

Pedro José Farias Fernandes
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Parte 1 - Interpretação de imagens

Elementos de interpretação de imagens

- Tonalidade
- Cor
- Textura
- Padrão
- Tamanho
- Forma
- Altura
- Localização
- Sombra



Landsat – 3 (B) 5(G) 4(R)

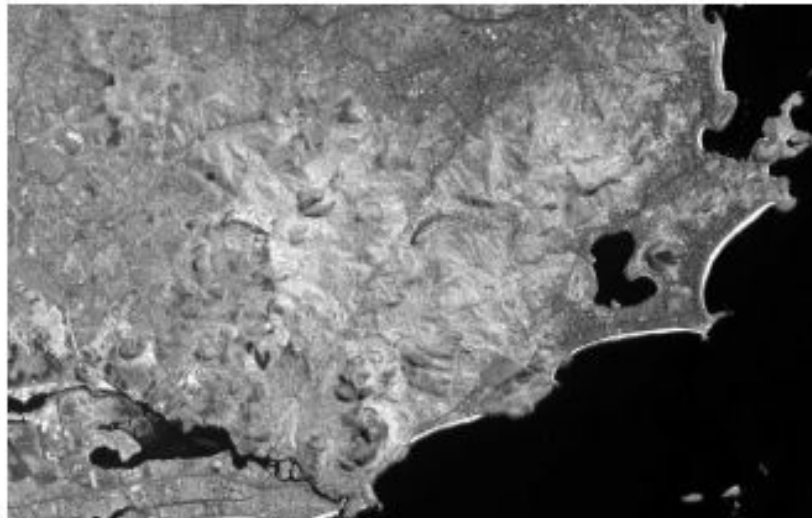


Landsat – 3(B) 4(G) 5(R)

Tonalidade (Landsat 5)



Vermelho

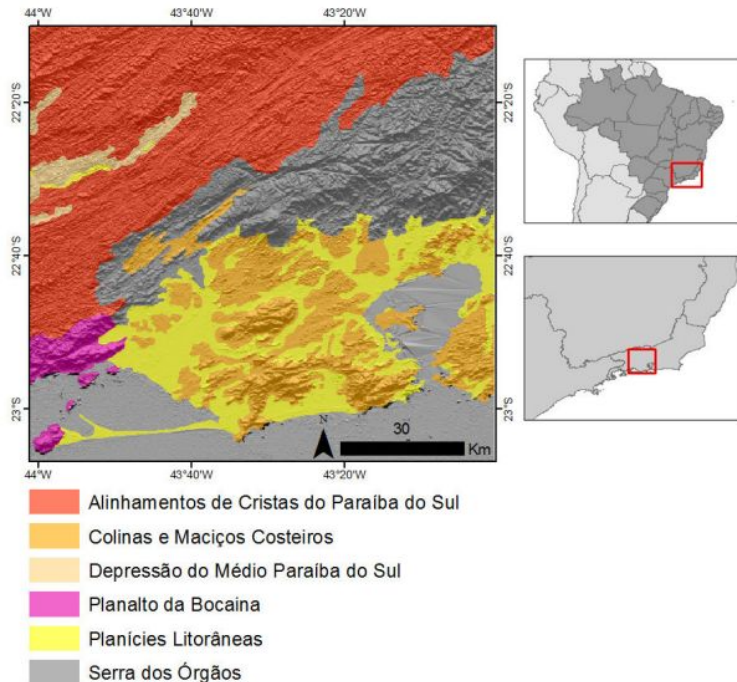


IV próximo

Textura e tonalidade (Imagem SAR-Sentinel 1)



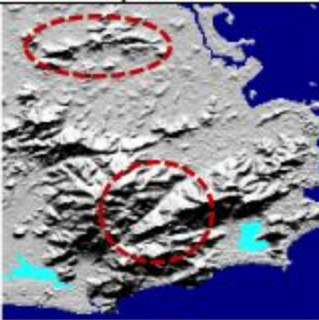
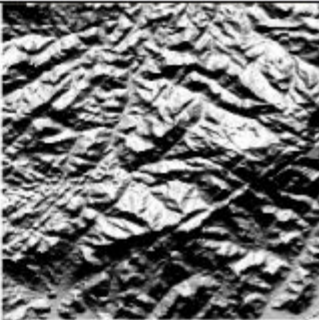
Textura, sombra e localização (SRTM Topodata)



Planalto da Bocaina	Área escarpada de declividade muito alta; rugosidade muito alta; localiza-se no contato com o Oceano.	
Planícies Litorâneas	Iguais aos critérios dos Depósitos Sedimentares da Tabela 3.1.	Igual a dos Depósitos Sedimentares da Tabela 3.2.
Serra dos Órgãos	Áreas que abrigam escarpas e relevos serranos; declividades altas e muito altas; rugosidade alta e muito alta; não se localiza no contato com o Oceano.	

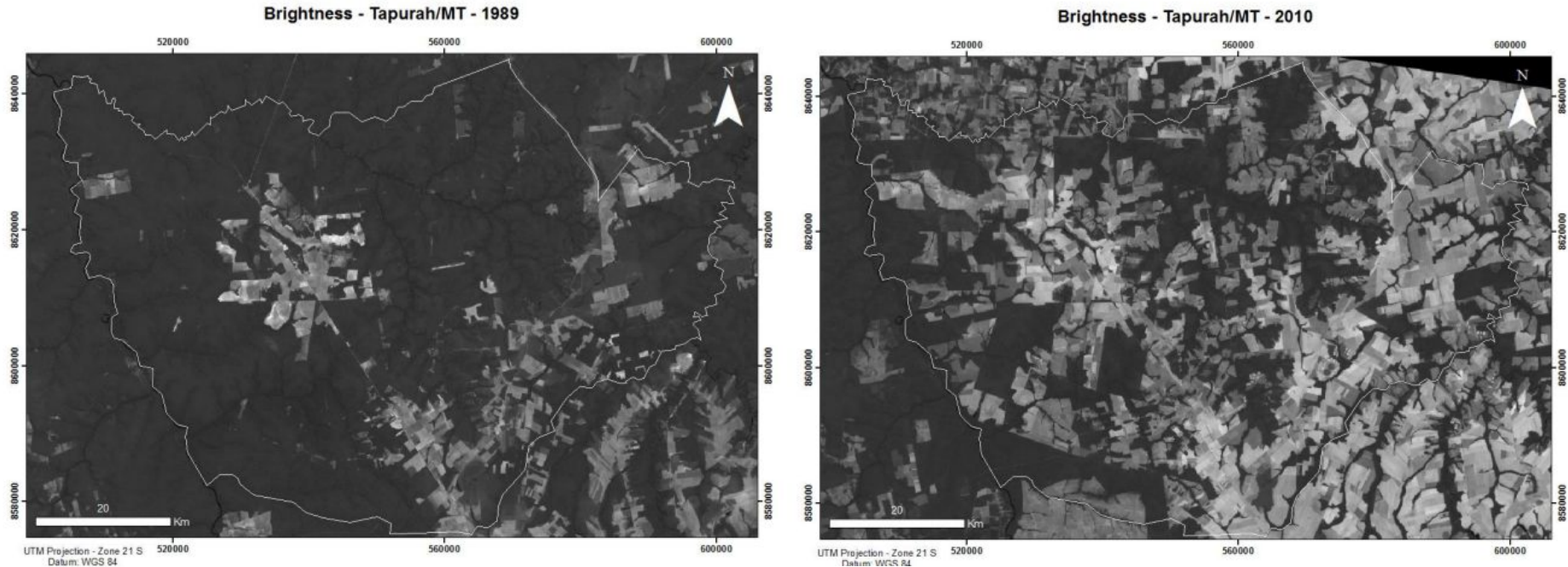
Chaves de interpretação

Tabela 3.3 – Chaves de interpretação das Regiões Geomorfológicas.

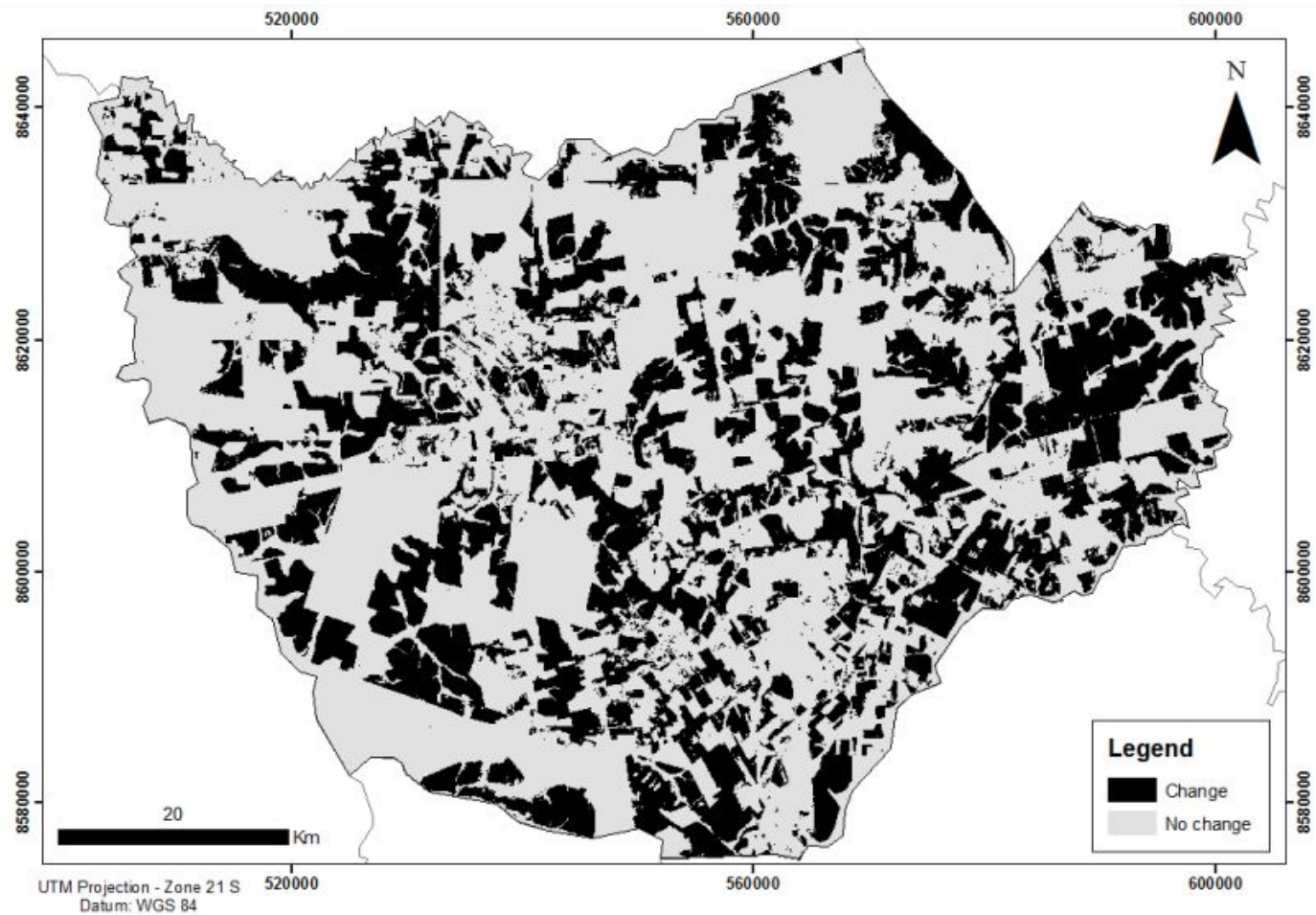
Segundo nível taxonômico (Regiões Geomorfológicas)		
Classe	Chaves de Interpretação	Aparência
Colinas e Maciços Costeiros	Áreas de declividades baixas até declividades altas; rugosidade baixa até alta rugosidade, circundadas por áreas planas de Depósitos Sedimentares; próximas à costa.	
Escarpas e Reversos da Serra do Mar	Áreas que abrigam escarpas e relevos serranos; declividades altas e muito altas; rugosidade alta e muito alta; localizadas no contato abrupto com Depósitos Sedimentares ou com o Oceano.	
Planícies Costeiras	Iguals aos critérios dos Depósitos Sedimentares da Tabela 3.1.	Igual a dos Depósitos Sedimentares da Tabela 3.2.

Parte 2 - Processamento de imagens

Georreferenciamento (change detection)

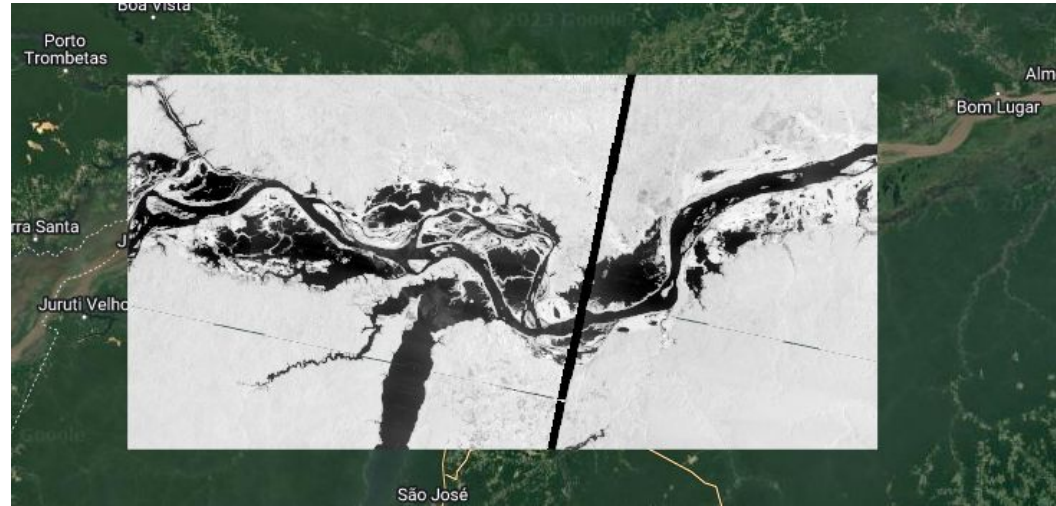


<https://seer.ufu.br/index.php/braziangeojournal/article/view/24886>

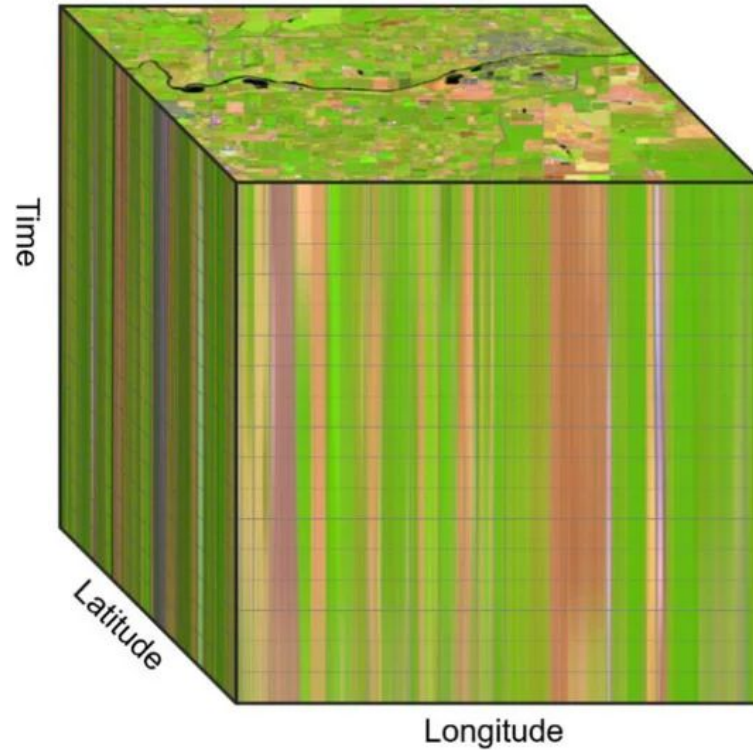


Georreferenciamento

Estabelece **relação geométrica entre os pixels da imagem e as coordenadas cartográficas**, com todos os pixels referenciados a um sistema de projeção cartográfica, através do ajuste de uma imagem ao sistema de coordenadas de outra imagem (IBGE, 1999).



Georreferenciamento



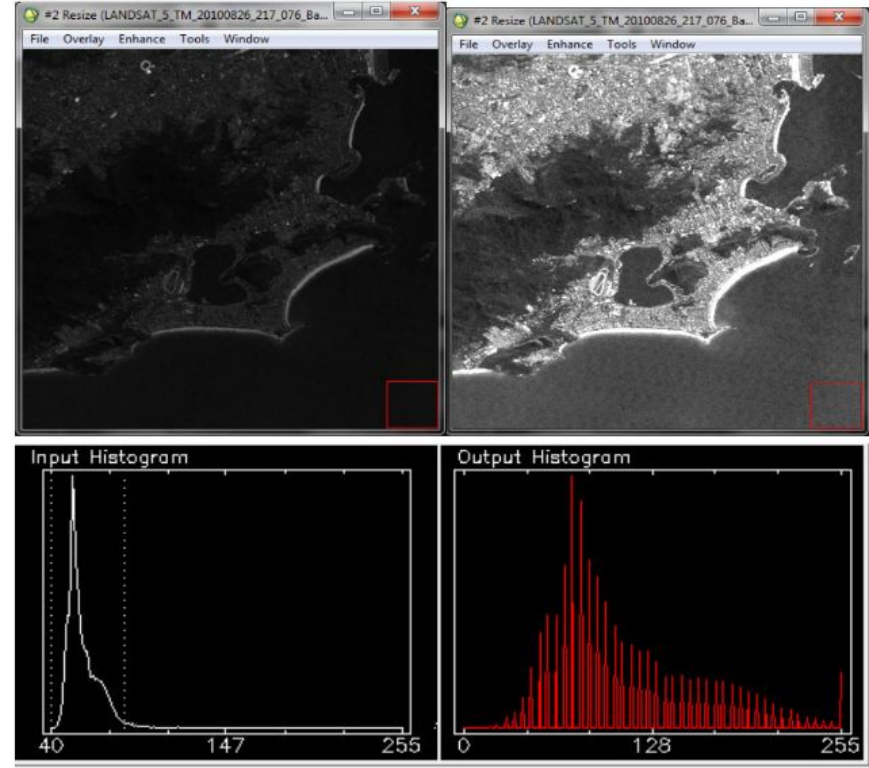
Contraste

O contraste da imagem refere-se à distribuição dos NC no intervalo radiométrico.

Geralmente, **os valores registrados pelo sensor ocupam uma pequena parte do intervalo possível de valores.**

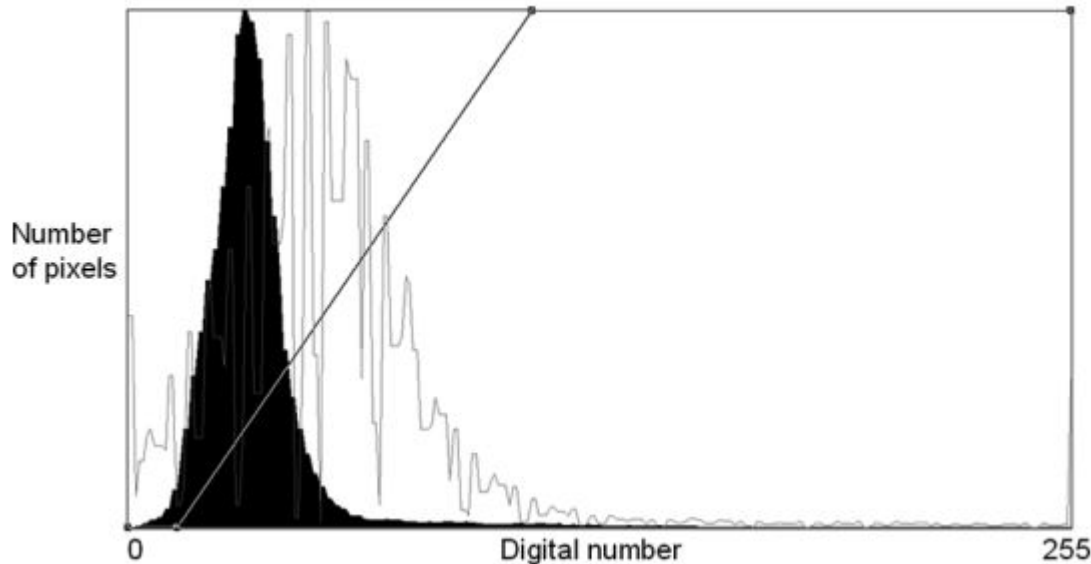
O realce de contraste produz uma ampliação do intervalo original de níveis de cinza, de forma que eles são exibidos num intervalo maior.

(IBGE, 1999)



Contraste linear

Define-se uma função linear que irá mapear os valores antigos dos pixels para novos valores, causando uma mudança no histograma.

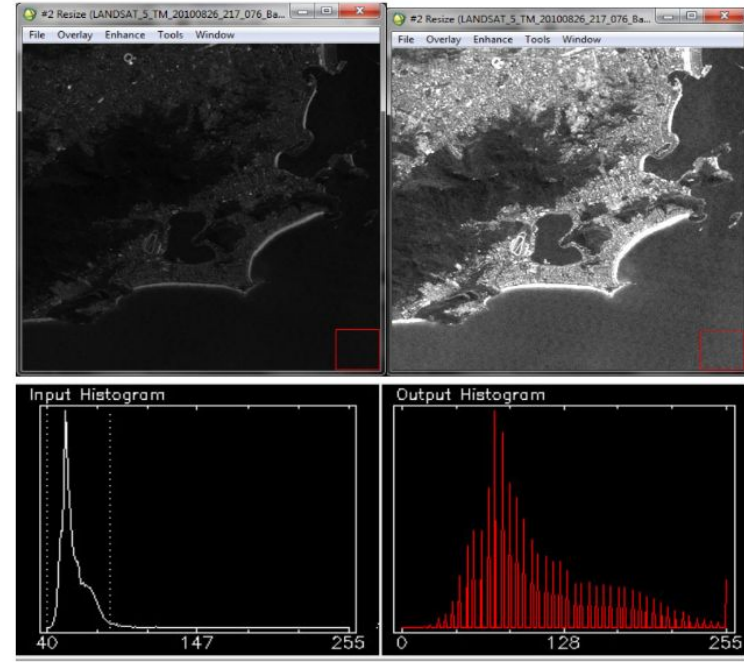


Fonte: Ramli, M. F., Tripathi, N. K., Yusof, N., Shafri, H. Z. M. and Ali Rahman, Z.(2009) 'Lineament mapping in a tropical environment using Landsat imagery', International Journal of Remote Sensing, 30: 23, 6277 — 6300

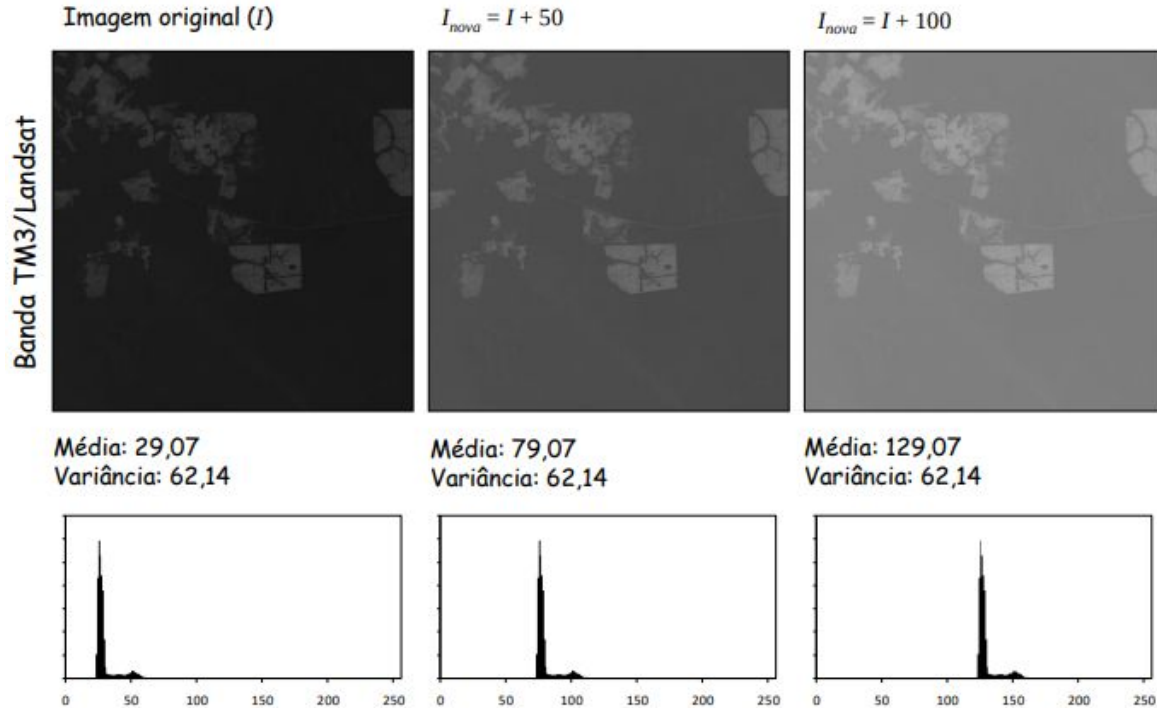
Contraste linear

Novo valor = $\text{ganho} * (\text{valor antigo}) + \text{offset}$

- **Média** está relacionada com o **brilho**
- **Contraste** está relacionado com a **variância**



Brilho da imagem

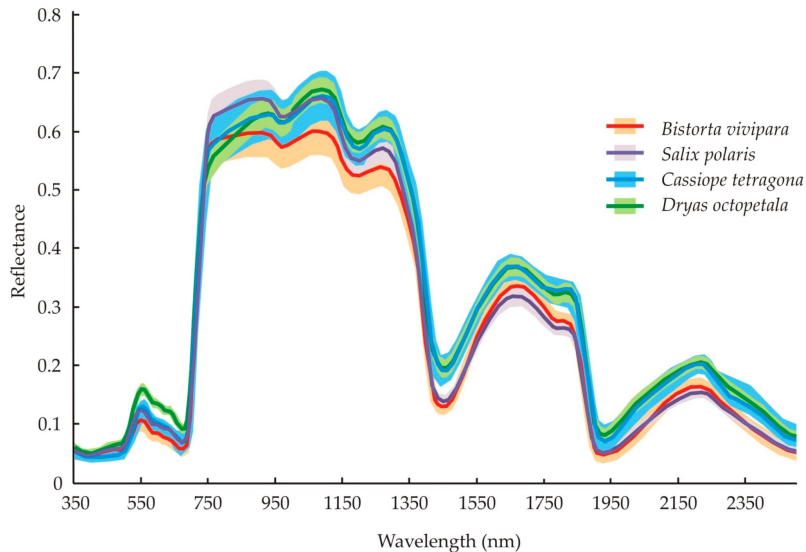


Fonte: Camilo Daleles Rennó -
<http://www.dpi.inpe.br/~camilo/estatistica/aulas.html>

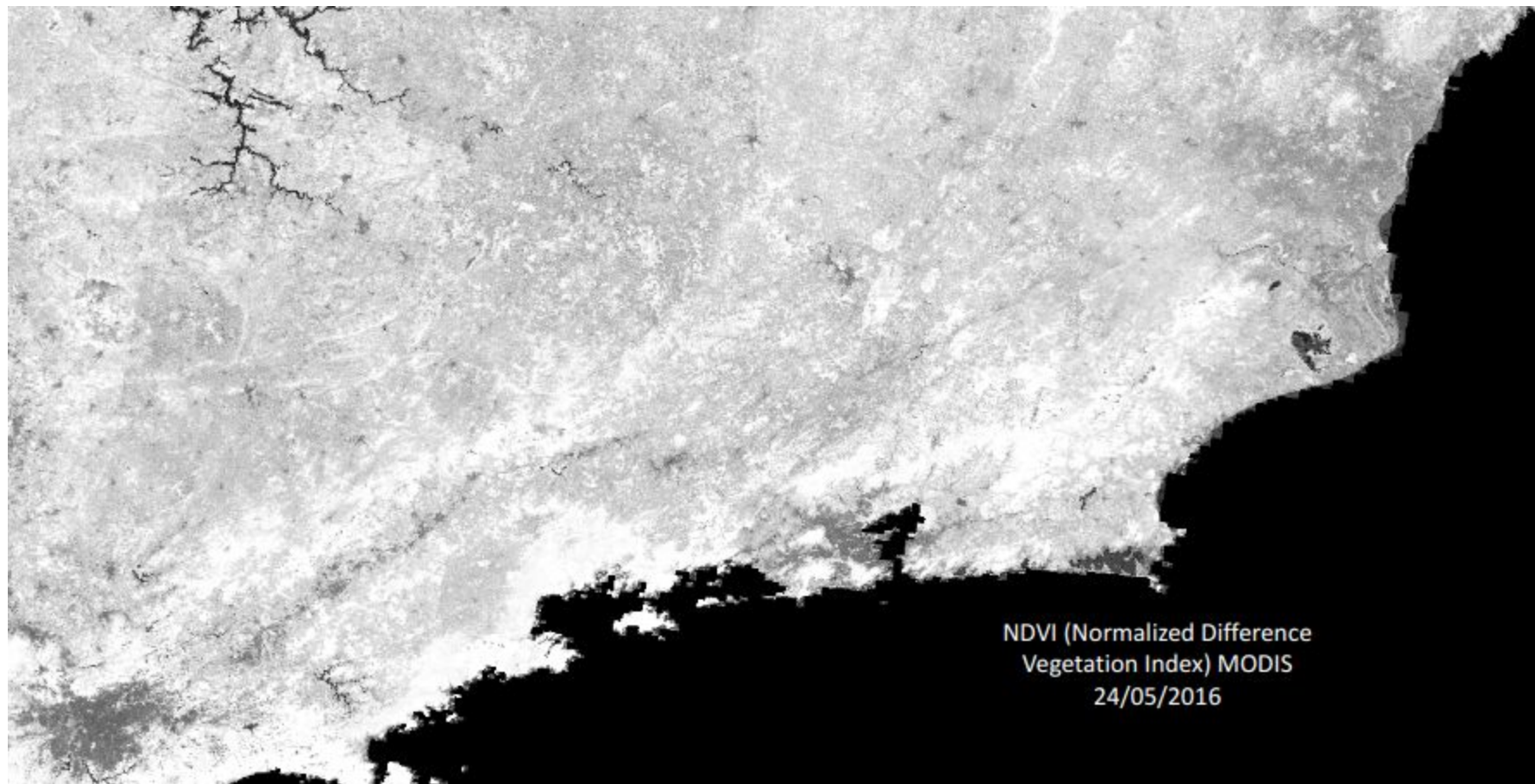
Parte 3 - Índices de Vegetação (IVs)

Índices de vegetação

Uma das principais aplicações das operações aritméticas é o cálculo de IVs que visam realçar a cobertura vegetal, servindo como indicadores de crescimento e vigor da vegetação. Relacionados com variáveis biofísicas da vegetação (biomassa, índice de área foliar, etc.)



Fonte: Zagajewski et al. (2017) -
<https://doi.org/10.3390/rs9121289>



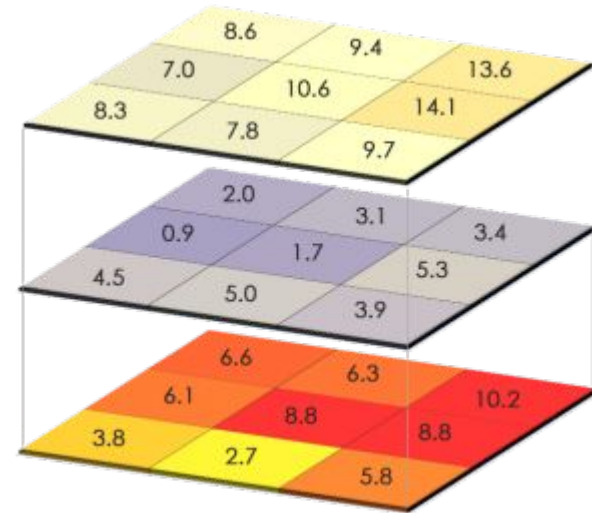
NDVI (Normalized Difference
Vegetation Index) MODIS
24/05/2016

Álgebra de bandas

$$A = \begin{bmatrix} 1 & 2 \\ 3 & 4 \\ 5 & 6 \end{bmatrix} \quad B = \begin{bmatrix} 2 & 1 \\ 8 & 4 \\ 5 & 10 \end{bmatrix} \Rightarrow$$

$$A - B = \begin{bmatrix} 1 - 2 & 2 - 1 \\ 3 - 8 & 4 - 4 \\ 5 - 5 & 6 - 10 \end{bmatrix} \Rightarrow$$

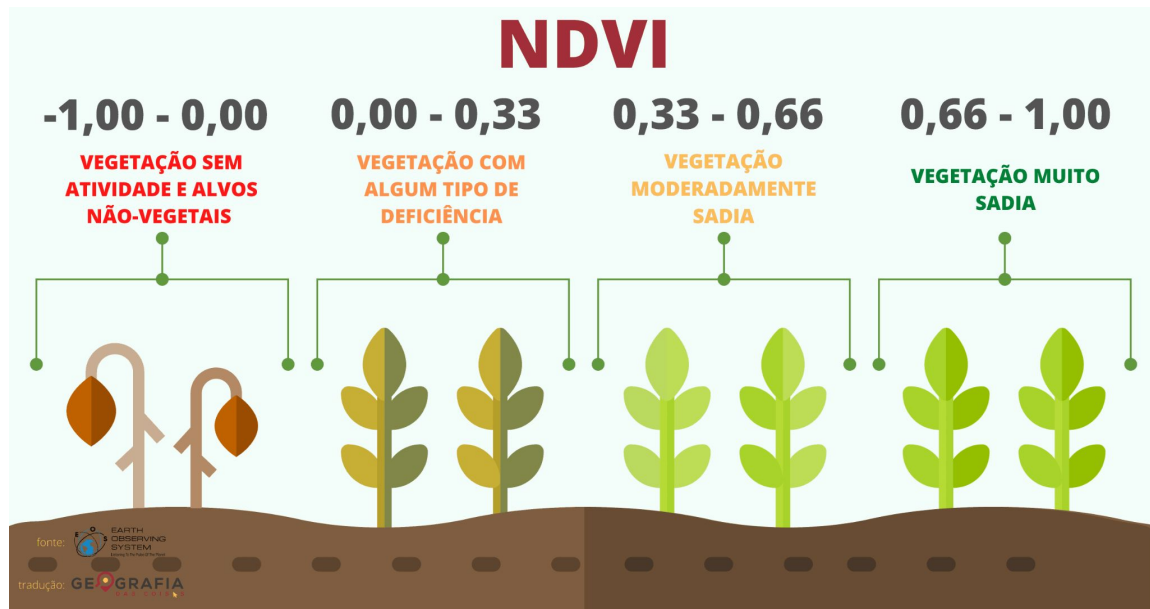
$$C = \begin{bmatrix} -1 & 1 \\ -5 & 0 \\ 0 & -4 \end{bmatrix}$$



<https://maticabasica.net/matrizes/>

<https://gisgeography.com/map-algebra-global-zonal-focal-local/>

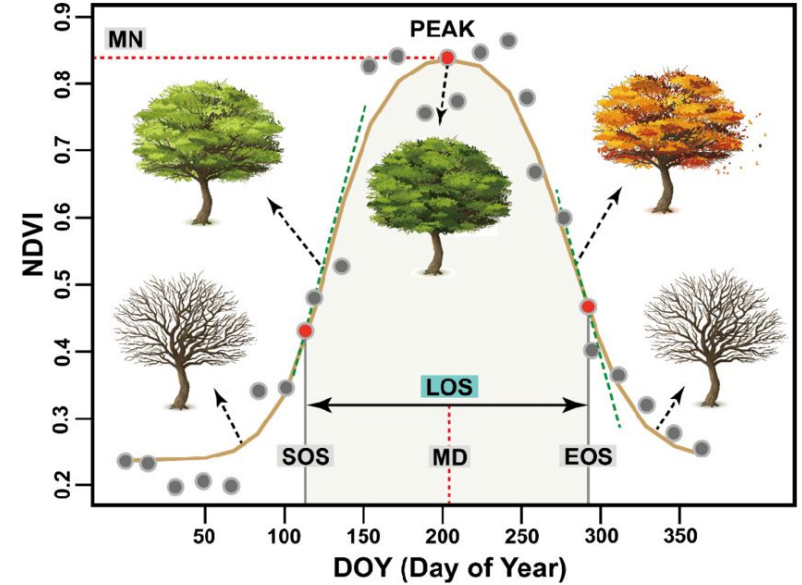
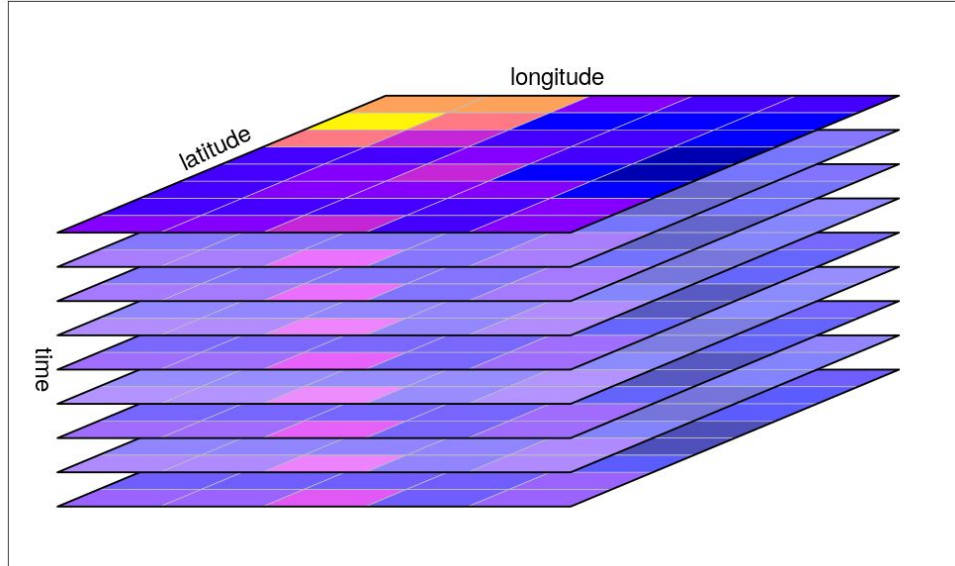
NDVI (Normalized Difference Vegetation Index)



$$\text{NDVI} = \frac{\text{NIR} - \text{RED}}{\text{NIR} + \text{RED}}$$

<https://geografiadascoisas.com.br/artigos/tudo-o-que-voce-precis-a-saber-sobre-o-ndvi-parte-1/>

NDVI

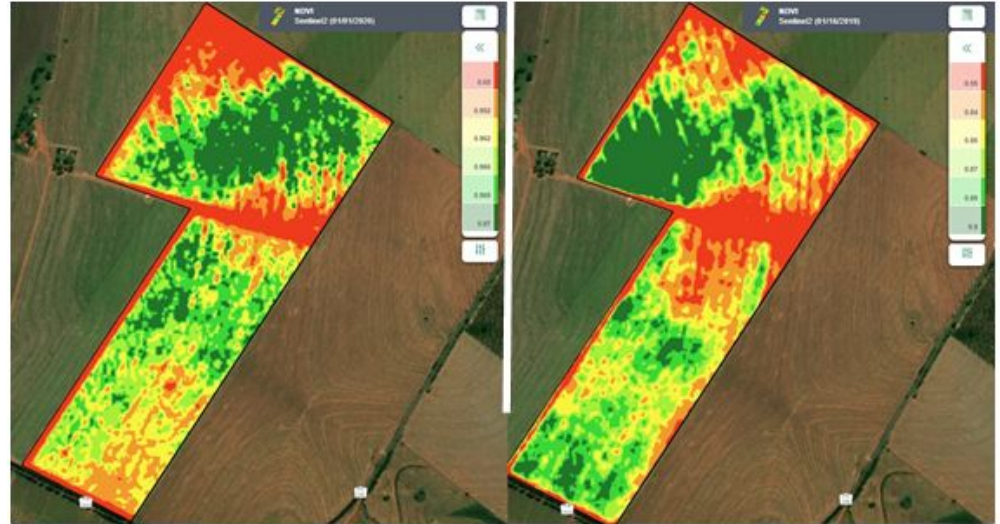


Guo, J.; Liu, X.; Ge, W.; Ni, X.; Ma, W.;
Lu, Q.; Xing, X. Specific Drivers and
Responses to Land Surface Phenology of
Different Vegetation Types in the Qinling
Mountains, Central China. *Remote Sens.*
2021, 13, 4538. <https://doi.org/10.3390/rs13224538>

NDVI - Agricultura de precisão



<https://stara.com.br/noticias/o-que-e-agricultura-de-precisao/>

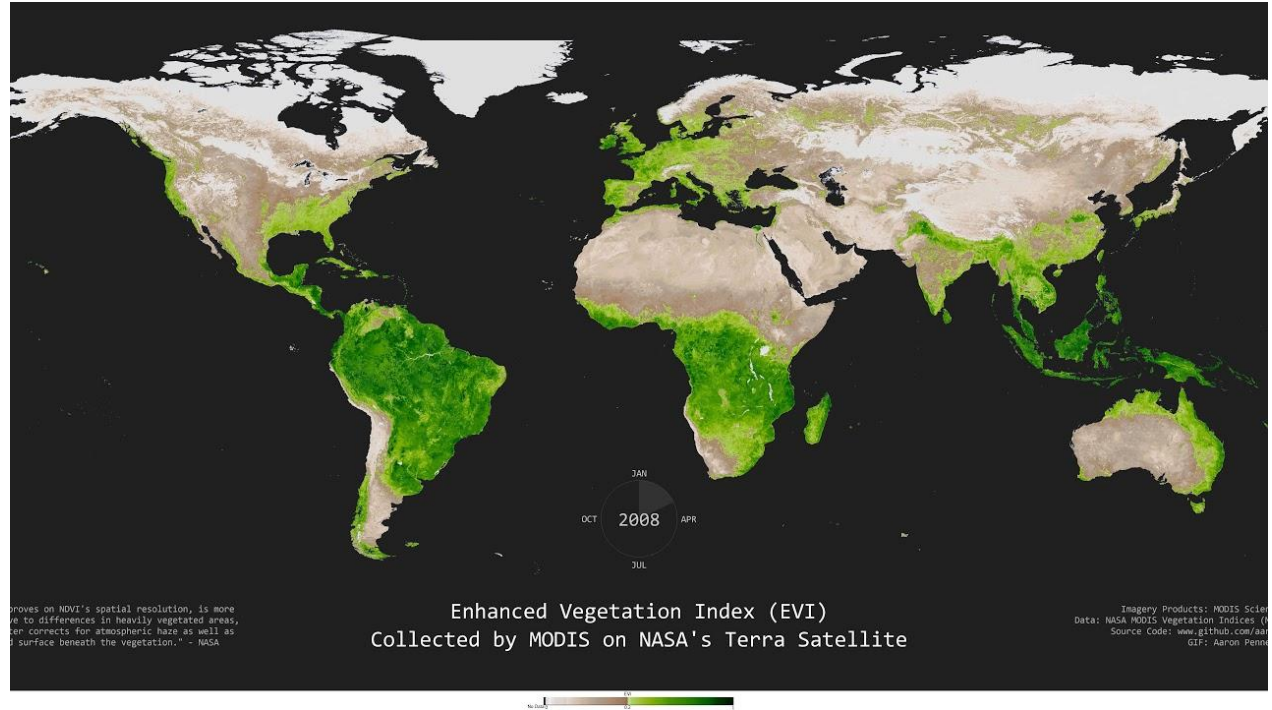


<https://www.cocarmaquinas.com.br/node/2440>

EVI (Enhanced Vegetation Index)

O NDVI satura para ambientes com alta biomassa, ou seja, ele deixa de ser sensível a partir de um certo valor de biomassa

Solução: EVI: mais sensível em regiões de alta biomassa, e sofre menos influência do solo e da atmosfera (PONZONI; SHIMABUKURO, 2009)



EVI (Enhanced Vegetation Index)

$$EVI = G * ((NIR - R) / (NIR + C1 * R - C2 * B + L)) - (Justice et al., 1998)$$

EVI para Landsat 5:

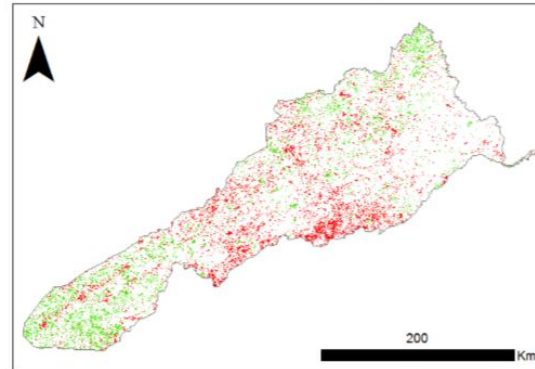
$$EVI = 2.5 * ((\text{Band 4} - \text{Band 3}) / (\text{Band 4} + 6 * \text{Band 3} - 7.5 * \text{Band 1} + 1))$$

Coefficientes Para MODIS:

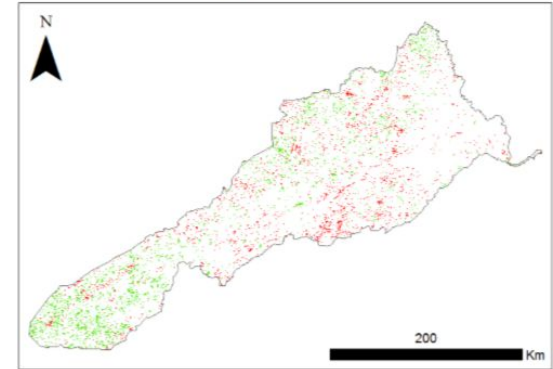
L=1, C1=6, C2=7.5, e G=2.5.





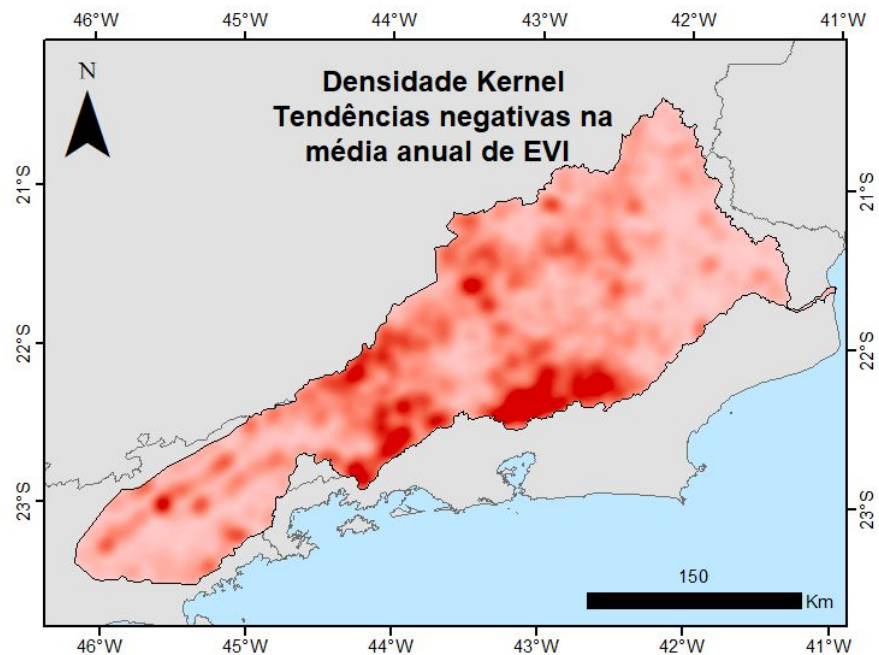
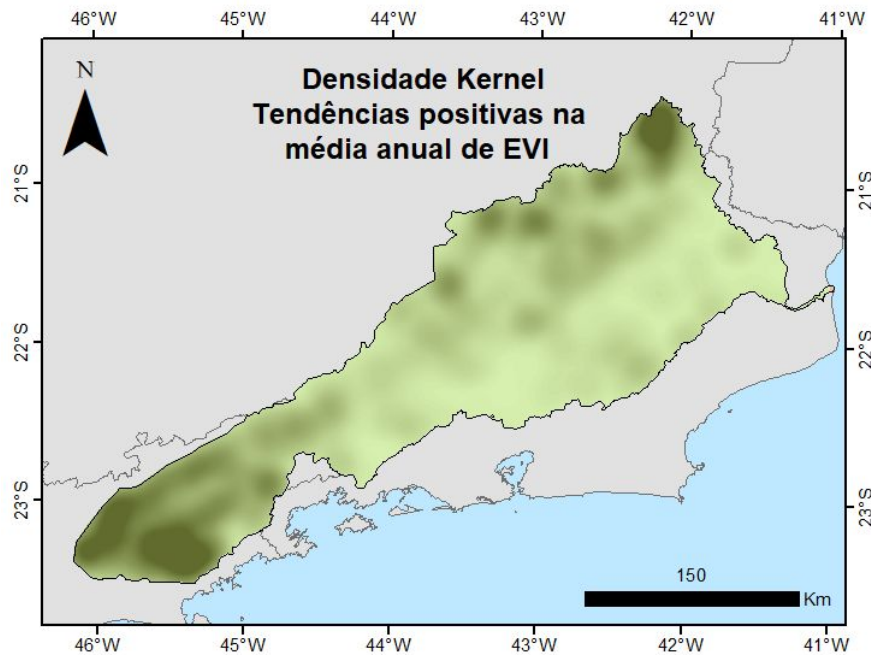
LM - Médias anuais



MK - D + PW

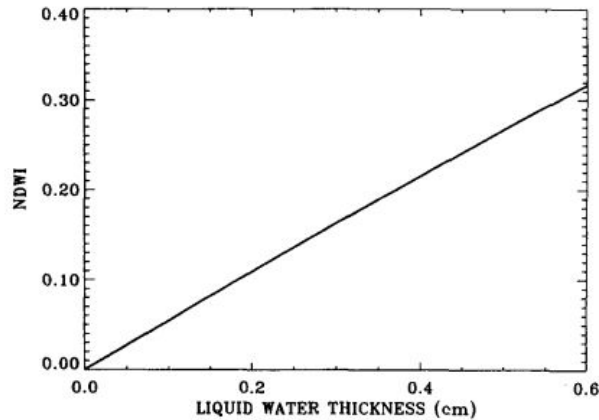


 Tendências negativas
 Tendências positivas



NDWI (Normalized Difference Water Index) - Gao (1996)

NDWI é sensível às mudanças no teor de água líquida do dossel.



$$NDWI = \frac{\rho(0.86 \mu m) - \rho(1.24 \mu m)}{\rho(0.86 \mu m) + \rho(1.24 \mu m)},$$

NDWI é menos sensível aos efeitos da atmosfera.

A informação espectral utilizada no NDWI é muito diferente da informação espectral do NDVI. **Logo, é um IV independente.**

Fórmulas NDWI para Landsat 5

Gao (1996): $NDWI = (B4 - B5) / (B4 + B5)$



Remote Sensing of Environment
Volume 58, Issue 3, December 1996, Pages 257-266



NDWI—A normalized difference water index for remote sensing of vegetation liquid water from space

Bo-cai Gao *

McFeeters (1996): $NDWI = (B2 - B4) / (B2 + B4)$

Remote Sensing Letters

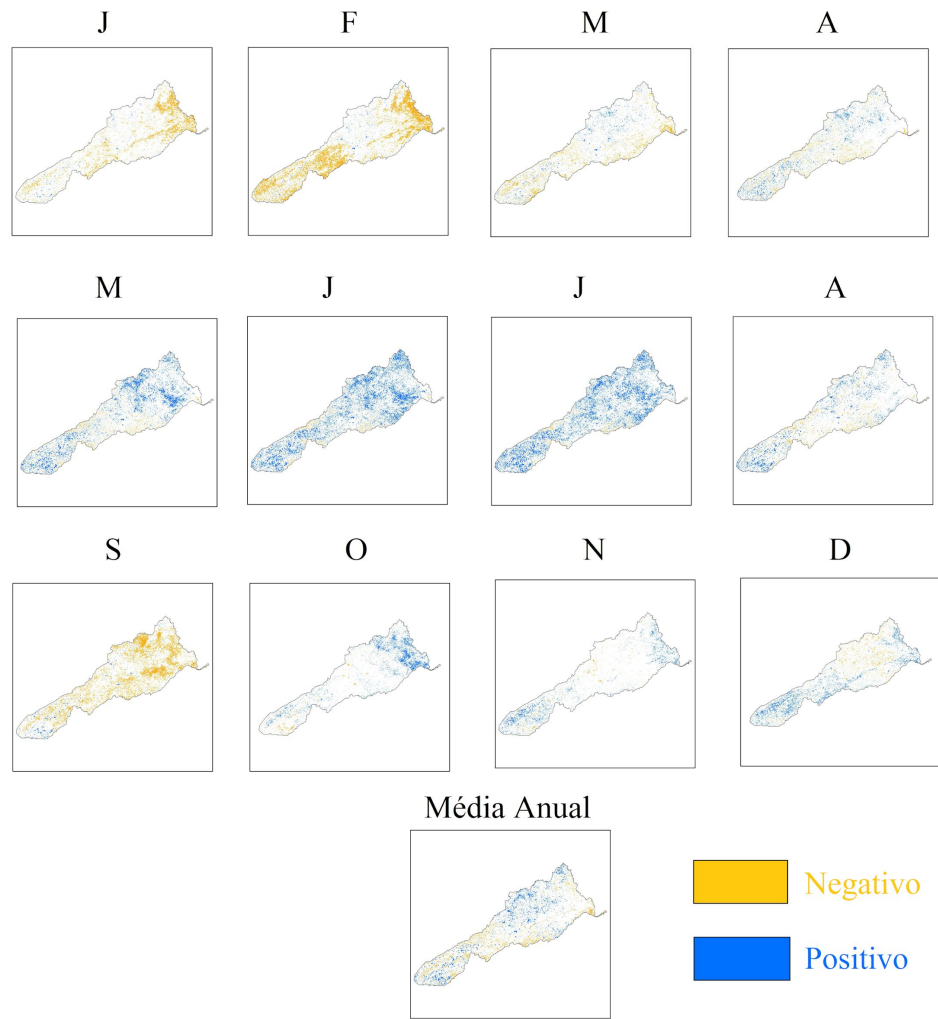
The use of the Normalized Difference Water Index (NDWI) in the delineation of open water features

S. K. McFEETERS

Pages 1425-1432 | Received 25 May 1995, Accepted 04 Jan 1996, Published online: 27 Apr 2007

“ Cite this article <https://doi.org/10.1080/01431169608948714>

Tendências NDWI



MNDWI (NDWI MODIFICADO)

Xu, H. Modification of normalised difference water index (NDWI) to enhance open water features in remotely sensed imagery. Int. J. Remote Sens. 2006, 27, 3025–3033

$$MNDWI = \frac{Green - MIR}{Green + MIR}$$



MMRI (Modular Mangrove Recognition Index)



remote sensing



Article

Brazilian Mangrove Status: Three Decades of Satellite Data Analysis

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⁴ Global Land Analysis and Discovery (GLAD) laboratory, Department of Geographical Sciences, University of Maryland, College Park, MD 20742, USA

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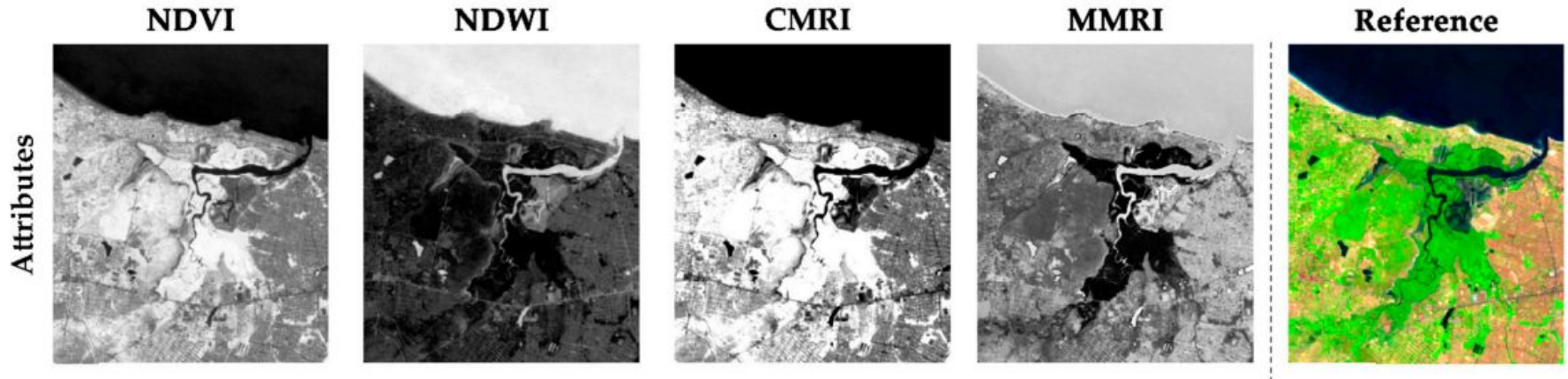


Abstract: Since the 1980s, mangrove cover mapping has become a common scientific task. However, the systematic and continuous identification of vegetation cover, whether on a global or regional scale, demands large storage and processing capacities. This manuscript presents a Google Earth Engine (GEE)-managed pipeline to compute the annual status of Brazilian mangroves from 1985 to 2018, along with a new spectral index, the Modular Mangrove Recognition Index (MMRI), which has been specifically designed to better discriminate mangrove forests from the surrounding vegetation. If compared separately, the periods from 1985 to 1998 and 1999 to 2018 show distinct mangrove area trends. The first period, from 1985 to 1998, shows an upward trend, which seems to be related more to the uneven distribution of Landsat data than to a regeneration of Brazilian mangroves. In the second period, from 1999 to 2018, a trend of mangrove area loss was registered, reaching up to 2% of the mangrove forest. On a regional scale, ~85% of Brazil's mangrove cover is in the states of Maranhão, Pará, Amapá and Bahia. In terms of persistence, ~75% of the Brazilian mangroves remained unchanged for two decades or more.

MMRI (Diniz et al., 2019)

index within a normalized difference structure. Therefore, the MMRI is a combination of two classical indices, a vegetation and a water index, which enhances the mangrove cover contrast. Its equation is given by the following:

$$MMRI = \frac{|MNDWI| - |NDVI|}{|MNDWI| + |NDVI|} \quad (2)$$



Parte 4 - Google Earth Engine



Contents lists available at ScienceDirect

Remote Sensing of Environment

journal homepage: www.elsevier.com/locate/rse



Google Earth Engine: Planetary-scale geospatial analysis for everyone



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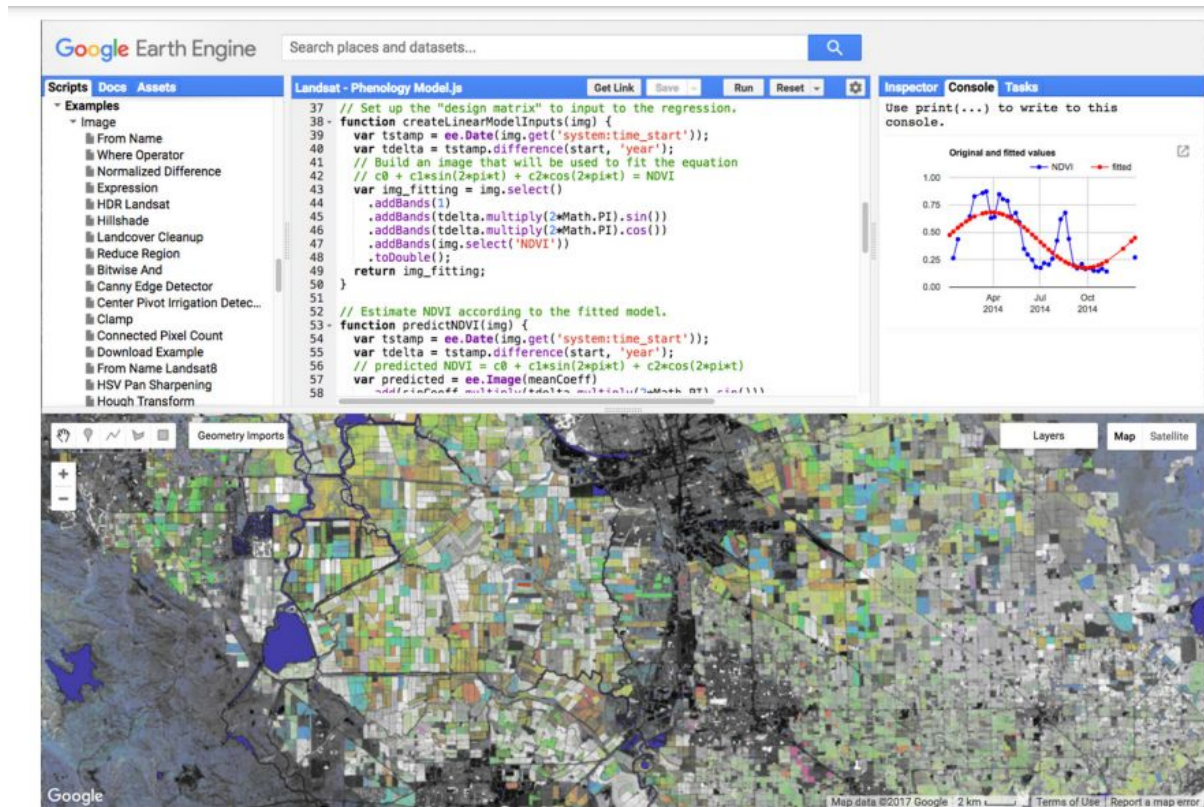
Earth Engine

ABSTRACT

Google Earth Engine is a cloud-based platform for planetary-scale geospatial analysis that brings Google's massive computational capabilities to bear on a variety of high-impact societal issues including deforestation, drought, disaster, disease, food security, water management, climate monitoring and environmental protection. It is unique in the field as an integrated platform designed to empower not only traditional remote sensing scientists, but also a much wider audience that lacks the technical capacity needed to utilize traditional supercomputers or large-scale commodity cloud computing resources.

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GEE - Gorelick et al. (2017)



```
UntitledFile [Get Link] [Save] [Run] [Reset] [Apps] [Settings]
Imports (1 entry)
  var geometry: Polygon, 4 vertices
1 //loading roi
2 var display = ee.Image(0).updateMask(0).paint(geometry, '000000', 2);
3 Map.centerObject(geometry, 7);
4 Map.addLayer(display, {palette:'000000'}, 'Geometry roi');
5
6 // Load Sentinel-1 C-band SAR Ground Range collection (log scale, VH, descending)
7 var Geometry VH = ee.ImageCollection('COPERNICUS/S1_GRD')
8   .filter(ee.Filter.eq('instrumentMode', 'IW'))
9   .filter(ee.Filter.listContains('transmitterReceiverPolarisation', 'VH'))
10  .filter(ee.Filter.eq('orbitProperties_pass', 'DESCENDING'))
11  .filterMetadata('resolution_meters', 'equals', 10)
12  .filterBounds(geometry)
13  .first()
```



Javascript

JS

```
ws.on("message", m => {  
  let a = m.split(" ")  
  switch(a[0]){  
    case "connect":  
      if(a[1]){  
        if(!clients.has(a[1])){  
          ws.send("connected");  
          ws.id = a[1];  
        }else{  
          ws.id = a[1]  
          clients.set(a[1], {client: position(a[1], p[0], p[1], p[2]), id: a[1]})  
          ws.send("connected")  
        }  
      }  
    }else{  
      let id = Math.random().toString().slice(2, 8)  
      ws.id = id;  
      clients.set(id, {client: position(a[1], p[0], p[1], p[2]), id: id})  
    }  
  }  
})
```