Laboratorio 3:

Análisis GeoEspacial y Sensores Remotos

Monitoreo de Deforestación en la Región de Petén, Guatemala usando Imágenes Sentinel-2

Autores:

- José Rodrigo Marchena – 22398
- Sofía Velasquez – 22049

In [ ]:
```
#!pip install rasterio
```

```
Collecting rasterio
  Downloading rasterio-1.3.11-cp38-cp38-win_amd64.whl (24.8 MB)
Collecting affine
  Using cached affine-2.4.0-py3-none-any.whl (15 kB)
Collecting attrs
  Using cached attrs-25.3.0-py3-none-any.whl (63 kB)
Collecting click-plugins
  Using cached click_plugins-1.1.1.2-py2.py3-none-any.whl (11 kB)
Collecting snuggs>=1.4.1
  Downloading snuggs-1.4.7-py3-none-any.whl (5.4 kB)
Collecting cligj>=0.5
  Using cached cligj-0.7.2-py3-none-any.whl (7.1 kB)
Requirement already satisfied: setuptools in c:\program files\windowsapps\pythonsoft
warefoundation.python.3.8_3.8.2800.0_x64__qbz5n2kfra8p0\lib\site-packages (from rast
erio) (56.0.0)
Requirement already satisfied: importlib-metadata in c:\users\50250\appdata\local\pa
ckages\pythonsoftwarefoundation.python.3.8_qbz5n2kfra8p0\localcache\local-packages\p
ython38\site-packages (from rasterio) (8.5.0)
Requirement already satisfied: certifi in c:\users\50250\appdata\local\packages\pyth
onsoftwarefoundation.python.3.8_qbz5n2kfra8p0\localcache\local-packages\python38\sit
e-packages (from rasterio) (2025.8.3)
Requirement already satisfied: numpy in c:\users\50250\appdata\local\packages\python
softwarefoundation.python.3.8_qbz5n2kfra8p0\localcache\local-packages\python38\site-
packages (from rasterio) (1.24.4)
Collecting click>=4.0
  Using cached click-8.1.8-py3-none-any.whl (98 kB)
Requirement already satisfied: colorama in c:\users\50250\appdata\local\packages\pyt
honsoftwarefoundation.python.3.8_qbz5n2kfra8p0\localcache\local-packages\python38\si
te-packages (from click>=4.0->rasterio) (0.4.6)
Requirement already satisfied: pyparsing>=2.1.6 in c:\users\50250\appdata\local\pack
ages\pythonsoftwarefoundation.python.3.8_qbz5n2kfra8p0\localcache\local-packages\pyt
hon38\site-packages (from snuggs>=1.4.1->rasterio) (3.1.4)
Requirement already satisfied: zipp>=3.20 in c:\users\50250\appdata\local\packages\p
ythonsoftwarefoundation.python.3.8_qbz5n2kfra8p0\localcache\local-packages\python38
\site-packages (from importlib-metadata->rasterio) (3.20.2)
Installing collected packages: click, snuggs, cligj, click-plugins, attrs, affine, r
asterio
Successfully installed affine-2.4.0 attrs-25.3.0 click-8.1.8 click-plugins-1.1.1.2 c
ligj-0.7.2 rasterio-1.3.11 snuggs-1.4.7
Note: you may need to restart the kernel to use updated packages.
WARNING: You are using pip version 21.1.1; however, version 25.0.1 is available.
You should consider upgrading via the 'C:\Users\50250\AppData\Local\Microsoft\Window
sApps\PythonSoftwareFoundation.Python.3.8_qbz5n2kfra8p0\python.exe -m pip install --
upgrade pip' command.
```

In [21]:

```python
import rasterio
import numpy as np
import matplotlib.pyplot as plt

# 1. Cargar imágenes con rasterio
ruta_rojo_2020 = "./images/2020-03-05_B04.tiff"
ruta_nir_2020 = "./images/2020-03-05_B08.tiff"
ruta_rojo_2024 = "./images/2024-05-03_B04.tiff"
ruta_nir_2024 = "./images/2024-05-03_B08.tiff"

with rasterio.open(ruta_rojo_2020) as src:
```

```
    rojo_2020 = src.read(1).astype('float32')
    profile = src.profile

with rasterio.open(ruta_nir_2020) as src:
    nir_2020 = src.read(1).astype('float32')

with rasterio.open(ruta_rojo_2024) as src:
    rojo_2024 = src.read(1).astype('float32')

with rasterio.open(ruta_nir_2024) as src:
    nir_2024 = src.read(1).astype('float32')
```

Parte 3: Cálculo de NDVI y Detección de Cambios

In [22]:
```
# Calcular NDVI para 2020 y 2024
ndvi_2020 = (nir_2020 - rojo_2020) / (nir_2020 + rojo_2020)
ndvi_2024 = (nir_2024 - rojo_2024) / (nir_2024 + rojo_2024)

# Imagen de diferencia
diferencia_ndvi = ndvi_2024 - ndvi_2020

# Umbral para pérdida significativa de vegetación
umbral = -0.2
mascara_deforestacion = diferencia_ndvi < umbral
```

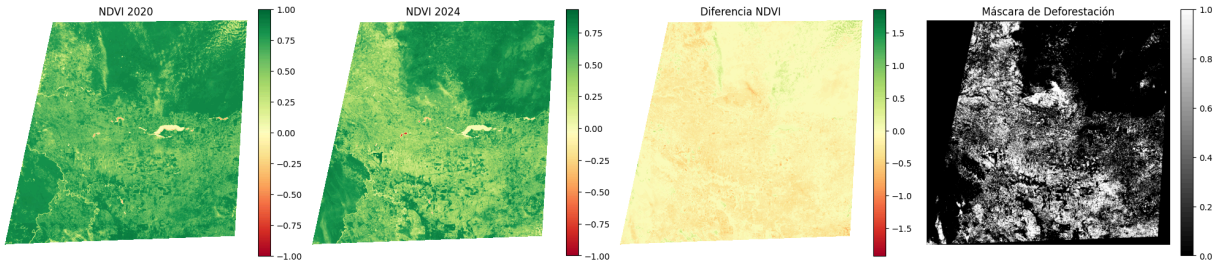
```
C:\Users\50250\AppData\Local\Temp\ipykernel_27184\1678254690.py:2: RuntimeWarning: i
nvalid value encountered in divide
  ndvi_2020 = (nir_2020 - rojo_2020) / (nir_2020 + rojo_2020)
C:\Users\50250\AppData\Local\Temp\ipykernel_27184\1678254690.py:3: RuntimeWarning: i
nvalid value encountered in divide
  ndvi_2024 = (nir_2024 - rojo_2024) / (nir_2024 + rojo_2024)
```

Parte 4: Visualización y Reporte

In [23]:
```
# Visualizaciones
fig, axs = plt.subplots(1, 4, figsize=(20, 6))
imgs = [
    (ndvi_2020, "NDVI 2020"),
    (ndvi_2024, "NDVI 2024"),
    (diferencia_ndvi, "Diferencia NDVI"),
    (mascara_deforestacion, "Máscara de Deforestación")
]

for ax, (img, title) in zip(axs, imgs):
    im = ax.imshow(img, cmap='RdYlGn' if "NDVI" in title else 'gray')
    ax.set_title(title)
    ax.axis('off')
    fig.colorbar(im, ax=ax, fraction=0.046, pad=0.04)

plt.tight_layout()
plt.show()
```



In [ ]:
```
# Calcular área de deforestación en porcentaje
pixeles_totales = mascara_deforestacion.size
pixeles_deforestados = np.sum(mascara_deforestacion)
porcentaje_deforestacion = (pixeles_deforestados / pixeles_totales) * 100

print(f"Área de deforestación: {porcentaje_deforestacion:.2f}%")
```

```
Área de deforestación: 24.39%
```