

PROYECTO SATELITES SOCIALES

La Noticia

Después de años de sequía,
Ciudad del Cabo está cerca de
quedarse sin agua

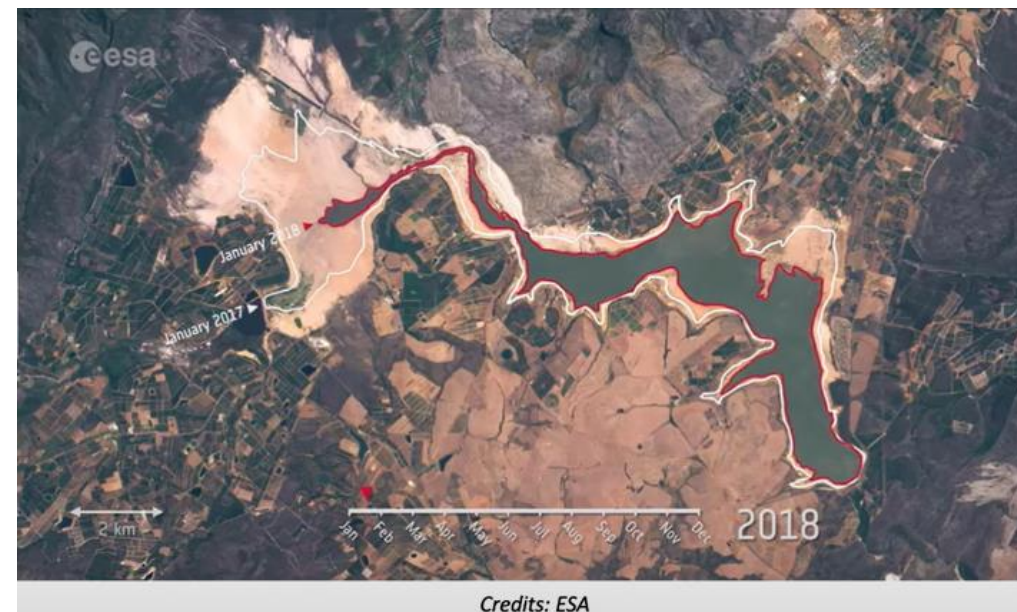
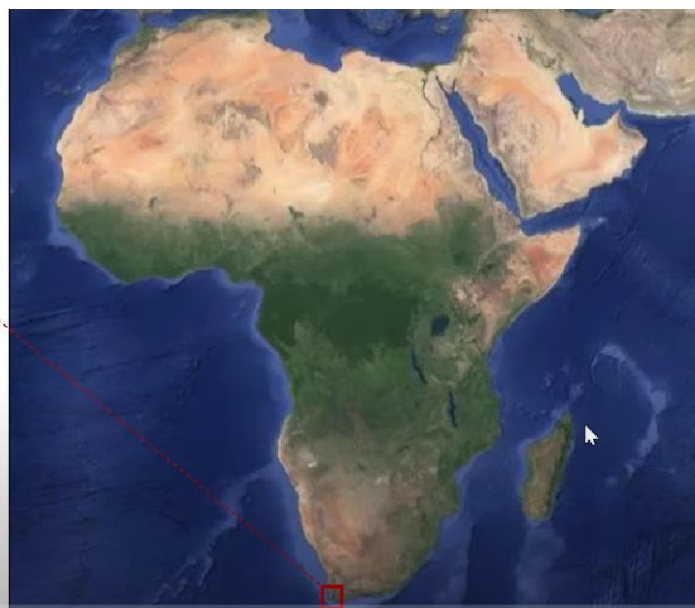
Satélites: Sentinel-2

Autor: Manuel Dávila Sguerra

Estas publicaciones presentan de forma general los procedimientos para llegar a resultados concretos. Intentamos hacer pedagogía en el tema de la lectura de imágenes satelitales además de obtener resultados finales

El sitio

Foto Cape Town Surafrica.....



Aquí vamos a comentar sobre la metodología para hacer un análisis de detección de sequías

Búsqueda del territorio utilizando Open Access Hub

The screenshot displays the Copernicus Open Access Hub search interface. The browser address bar shows the URL <https://scihub.copernicus.eu/dhus/#/home>. The interface includes a search bar at the top left and an 'Advanced Search' panel on the left side. The search filters are as follows:

- Sort By:** Ingestion Date (Descending)
- Order By:** Descending
- Sensing period:** 2015/08/10 to 2020/11/11
- Ingestion period:** (empty)
- Mission:** Sentinel-1 (selected)
- Mission: Sentinel-2:** Satellite Platform: S2A_*, Relative Orbit Number: 121
- Mission: Sentinel-3:** (empty)

The main map area shows a satellite image of a region in South Africa, with a large orange rectangular area highlighting a specific region. The map includes labels for various locations such as Paarl, Stellenbosch, Villiersdorp, and Hermanus. The bottom of the screen shows the Windows taskbar with the search bar containing 'Escribe aquí para buscar' and the system tray displaying the date and time as 9:58 a.m. on 22/12/2021.

Remover los efectos atmosféricos con diversas imágenes multitemporales utilizando en procesador **sen2cor**

Los archivos bajado tienen en nivel **1C** y se debe buscar los registros con el nivel **2 A** utilizando el procesador **sen2cor**

S2A_MSIL**1C**_20200225T081921_N0209_R121_T34HCH_20200225T104030.zip



Figure 3.3. Sentinel-2 satellite. (Astrium GmbH, Germany)

Sen2Cor es un procesador para la generación y formateo de productos Sentinel-2 Nivel 2A; realiza la corrección atmosférica, del terreno y de los cirros de los datos de entrada de nivel 1C de la parte superior de la atmósfera. Sen2Cor crea imágenes de reflectancia corregidas en el fondo de la atmósfera, opcionalmente en el terreno y en cirros; y adicionalmente, espesor óptico de aerosol, vapor de agua, mapa de clasificación de escenas e indicadores de calidad para probabilidades de nubes y nieve.

Bandas normal 4,3,2

The screenshot displays the QGIS interface with a satellite image loaded. The main window shows a natural RGB composite of satellite bands 4, 3, and 2. On the left, the Product Explorer panel lists various data layers, including metadata, vector data, and bands like NDWI, MNDWI, and AWEI. The bottom-left panel shows a histogram for the B4 band, with a red color bar below it. The histogram shows a distribution of values from approximately 5.81E-3 to 0.2. The bottom status bar indicates the current location: X 3160 Y 4616 | Lat 33°50'31" S Lon 19°10'48" E | Zoom 1:169.7 Level 4.

Product Explorer x Pixel Info

- [1] S2A_MSIL2A_20160406T081652_N0201_R121_T34HCH_20160406T083818
- [2] S2A_MSIL2A_20160824T081602_N0204_R121_T34HCH_20160824T084517
- [3] S2A_MSIL2A_20170809T081601_N0205_R121_T34HCH_20170809T084800
- [4] S2A_MSIL2A_20191217T082341_N0213_R121_T34HCH_20191217T104906
- [5] S2A_MSIL2A_20200225T081921_N0209_R121_T34HCH_20200225T104030
- [6] Subset_Output Product_resampled
- [7] Subset_S2A_MSIL2A_20160824T081602_N0204_R121_T34HCH_20160824T084517_resamp
- [8] Subset_S2A_MSIL2A_20170809T081601_N0205_R121_T34HCH_20170809T084800_resamp
- [9] Subset_S2A_MSIL2A_20191217T082341_N0213_R121_T34HCH_20191217T104906_resamp
- [10] Subset_S2A_MSIL2A_20200225T081921_N0209_R121_T34HCH_20200225T104030_resamp
- [11] Subset_Output Product_resampled_BandMath
 - Metadata
 - Vector Data
 - Tie-Point Grids
 - Bands
 - NDWI
 - MNDWI5
 - MNDWI
 - AWEI
- [12] Subset_S2A_MSIL2A_20160824T081602_N0204_R121_T34HCH_20160824T084517_resamp

Navigation - [1] RGB Colour Manipulati... x Uncertainty Visualisa... World View

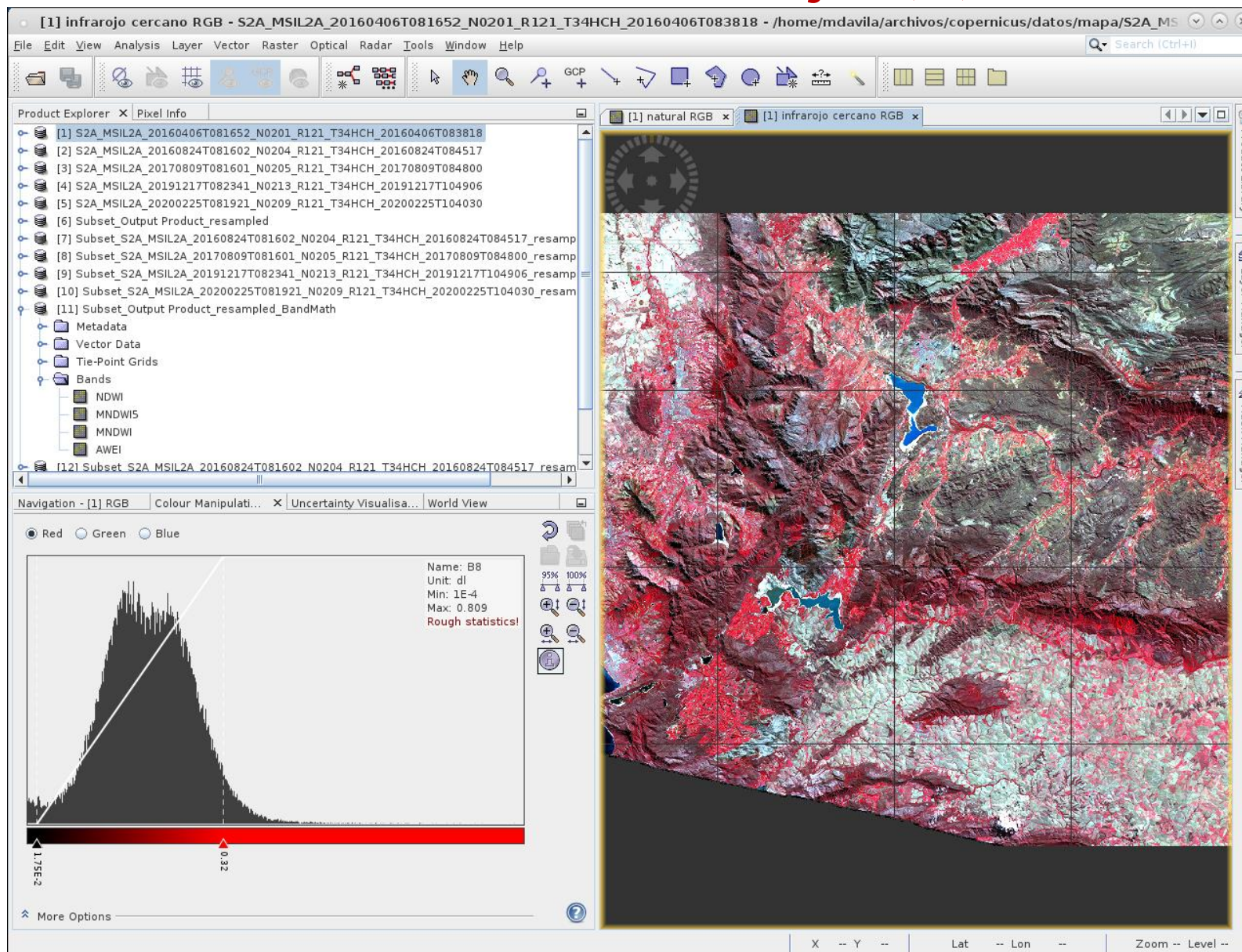
Red Green Blue

Name: B4
Unit: dl
Min: 1E-4
Max: 0.73
Rough statistics!

5.81E-3 0.2

X 3160 Y 4616 | Lat 33°50'31" S Lon 19°10'48" E | Zoom 1:169.7 Level 4

Bandas infrarrojo 8,4,3

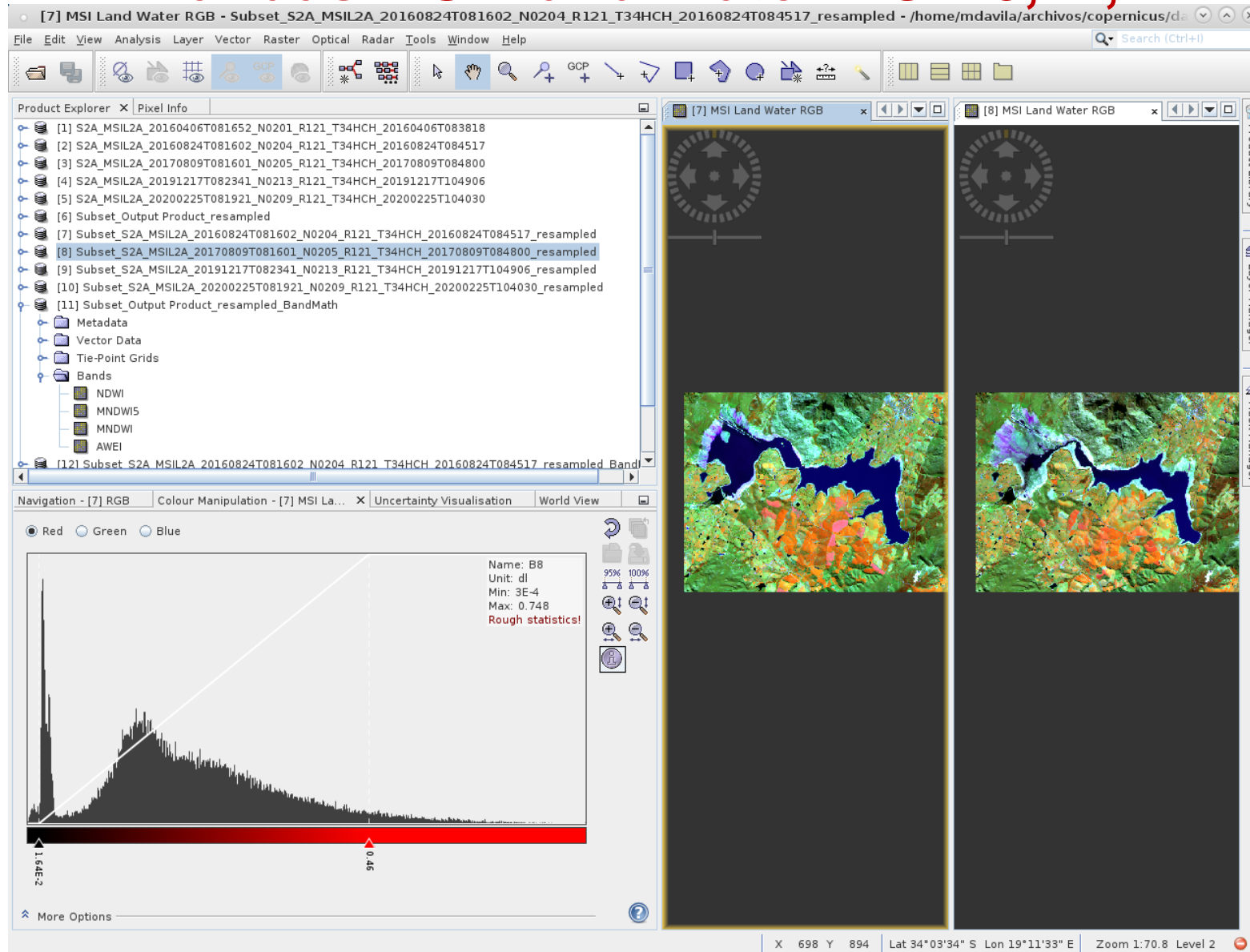


Ambas imágenes

The screenshot displays the QGIS interface with the following elements:

- Title Bar:** [1] infrarrojo cercano RGB - S2A_MSIL2A_20160406T081652_N0201_R121_T34HCH_20160406T083818 - /home/mdavila/archivos/copernicus/datos/mapa/S2A_MS
- Menu Bar:** File, Edit, View, Analysis, Layer, Vector, Raster, Optical, Radar, Tools, Window, Help
- Product Explorer:** Lists 11 layers, including S2A_MSIL2A products and their subsets.
- Layers Panel:** Shows 'Bands' with NDWI, MNDWI, and AWEI.
- Navigation:** Includes 'Colour Manipul...' and 'World View' tabs.
- Band Statistics:** A histogram for 'B8' (Name: B8, Unit: dl, Min: 1E-4, Max: 0.809) is shown with a red selection bar.
- Map View:** Two side-by-side satellite images of a landscape with a lake. The left image is false-color (red, green, blue), and the right is natural color.
- Status Bar:** X 3746 Y 6506 Lat 34°00'48" S Lon 19°14'23" E Zoom 1:49.2 Level 2

Bandas MSI Land Water RGB 8,11,4



The screenshot displays the QGIS interface for processing satellite data. The main window title is "[7] MSI Land Water RGB - Subset_S2A_MSIL2A_20160824T081602_N0204_R121_T34HCH_20160824T084517_resampled - /home/mdavila/archivos/copernicus/d...". The Product Explorer on the left lists 11 layers, with the 8th layer, "Subset_S2A_MSIL2A_20170809T081601_N0205_R121_T34HCH_20170809T084800_resampled", selected. The central map area shows two side-by-side satellite images of a landscape with a prominent blue water body. The bottom panel displays a histogram for the selected band (B8) with a red color bar below it. The histogram shows a distribution of values from approximately 1.64E-2 to 0.46. Statistics for the band are: Name: B8, Unit: dl, Min: 3E-4, Max: 0.748, and a note "Rough statistics!". The bottom status bar shows coordinates: X 698 Y 894, Lat 34°03'34" S Lon 19°11'33" E, Zoom 1:70.8 Level 2.

Índice NDWI Diferencia normalizada de agua



Water Radiometric Indices

Imagen en imagen

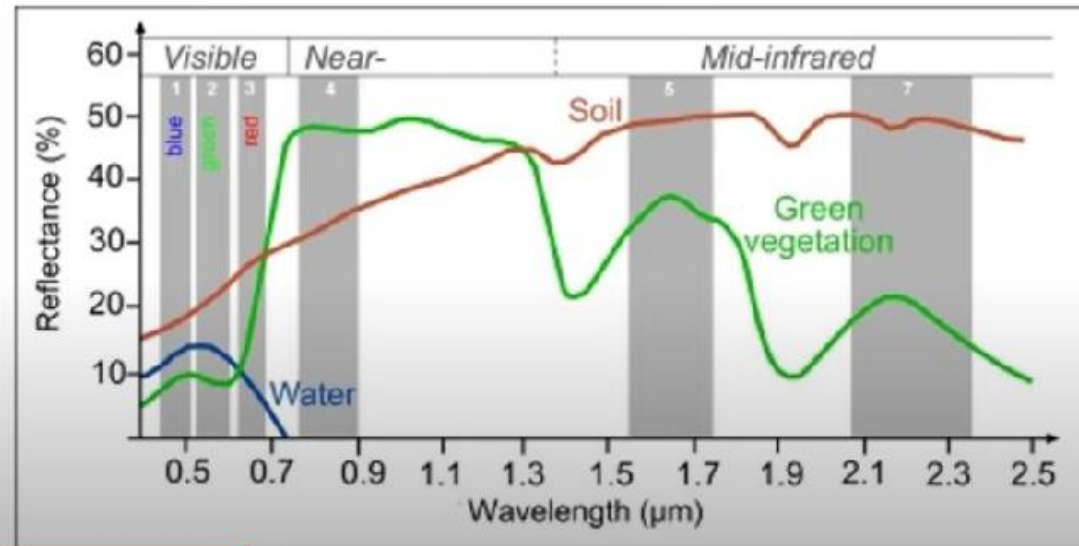
Normalized Difference Water Index
(NDWI)

$$NDWI = \frac{Green - NIR}{Green + NIR} = \frac{B3 - B8}{B3 + B8}$$

Water body:

Green band = High reflectance

NIR band = Low reflectance



47:27 / 1:29:54



Índices radiométricos que debemos obtener



Water Radiometric Indices

Modified Normalized
Difference Water Index
(MNDWI)

$$MNDWI = \frac{Green - SWIR1}{Green + SWIR1} = \frac{B3 - B11}{B3 + B11}$$

Modified Normalized
Difference Water Index
(MNDWI+5)

$$MNDWI + 5 = \frac{NIR - Red}{NIR + Red} = \frac{B8 - B4}{B8 + B4}$$

Automated Water Extraction
Index (AWEI)

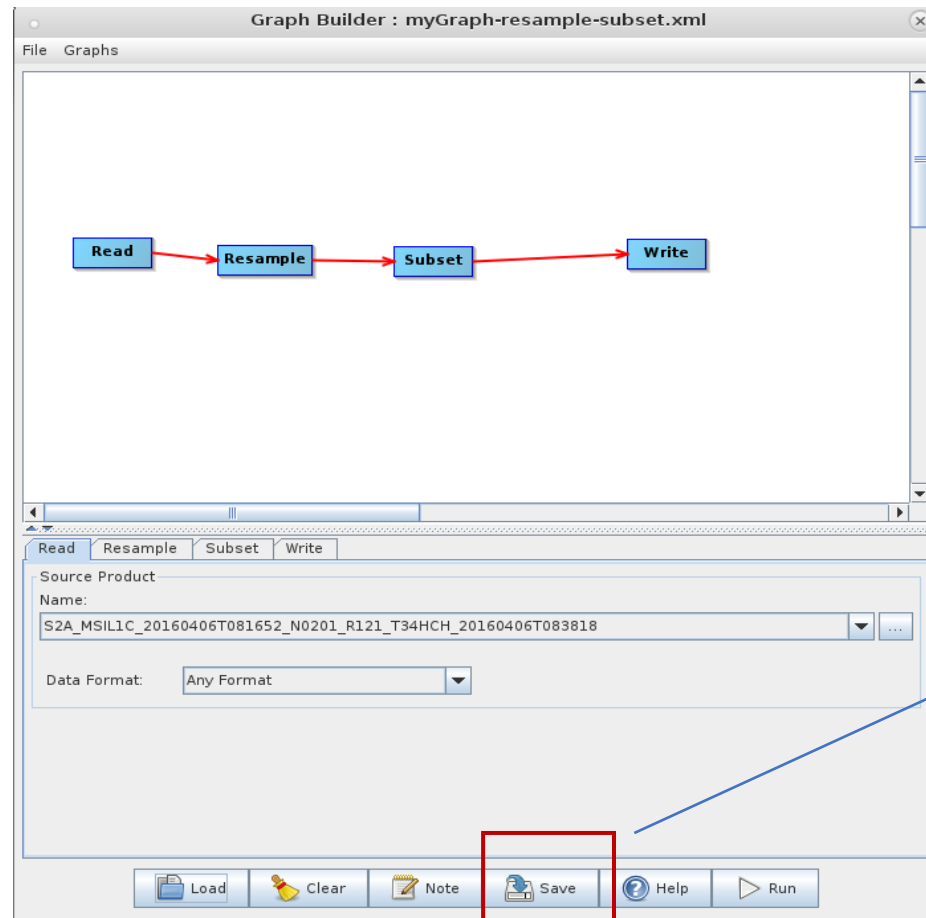
$$AWEI = Blue + 2.5 * Green - 1.5 * (NIR + SWIR1) - (0.25 * SWIR2) = \\ = B2 + 2.5 * B3 - 1.5 * (B8 - B11) - (0.25 * B12)$$



49:47 / 1:29:54



Reensamble de las bandas para que tengan la misma resolución y escoger un subconjunto del territorio



myGraph-resample-subset.xml

Mapas reducidos espacialmente con las bandas 8, 4, 3

Los archivos transformados a 2A se deben cargar en SNAP

The screenshot displays the QGIS desktop environment. The top menu bar includes File, Edit, View, Analysis, Layer, Vector, Raster, Optical, Radar, Tools, Window, and Help. The Product Explorer on the left lists ten satellite data files, with file [9] highlighted. The main map area is divided into three windows, each showing a different spatially reduced satellite image. The bottom-left window shows a globe with a location marker over the South Atlantic Ocean, labeled with coordinates 10, 9, 8, 7, 6, 5, 4, 3, 2, 1. The system tray at the bottom shows the user 'mdavila@debian' and several open applications.

Índices radiométricos del agua

RUS Water Radiometric Indices

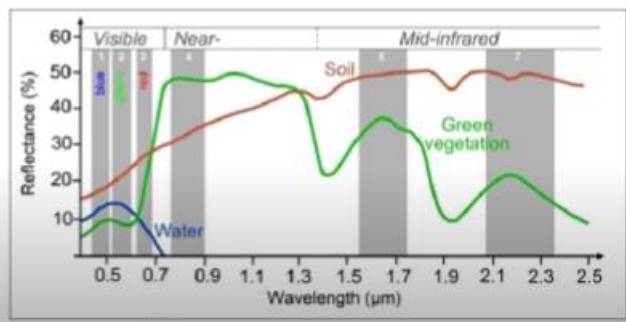
Normalized Difference Water Index
(NDWI)

$$NDWI = \frac{Green - NIR}{Green + NIR} = \frac{B3 - B8}{B3 + B8}$$

Water body:

Green band = High reflectance

NIR band = Low reflectance



RUS Water Radiometric Indices

Modified Normalized
Difference Water Index
(MNDWI)

$$MNDWI = \frac{Green - SWIR1}{Green + SWIR1} = \frac{B3 - B11}{B3 + B11}$$

Modified Normalized
Difference Water Index
(MNDWI+5)

$$MNDWI + 5 = \frac{NIR - Red}{NIR + Red} = \frac{B8 - B4}{B8 + B4}$$

Automated Water Extraction
Index (AWEI)

$$AWEI = Blue + 2.5 * Green - 1.5 * (NIR + SWIR1) - (0.25 * SWIR2) = B2 + 2.5 * B3 - 1.5 * (B8 + B11) - (0.25 * B12)$$

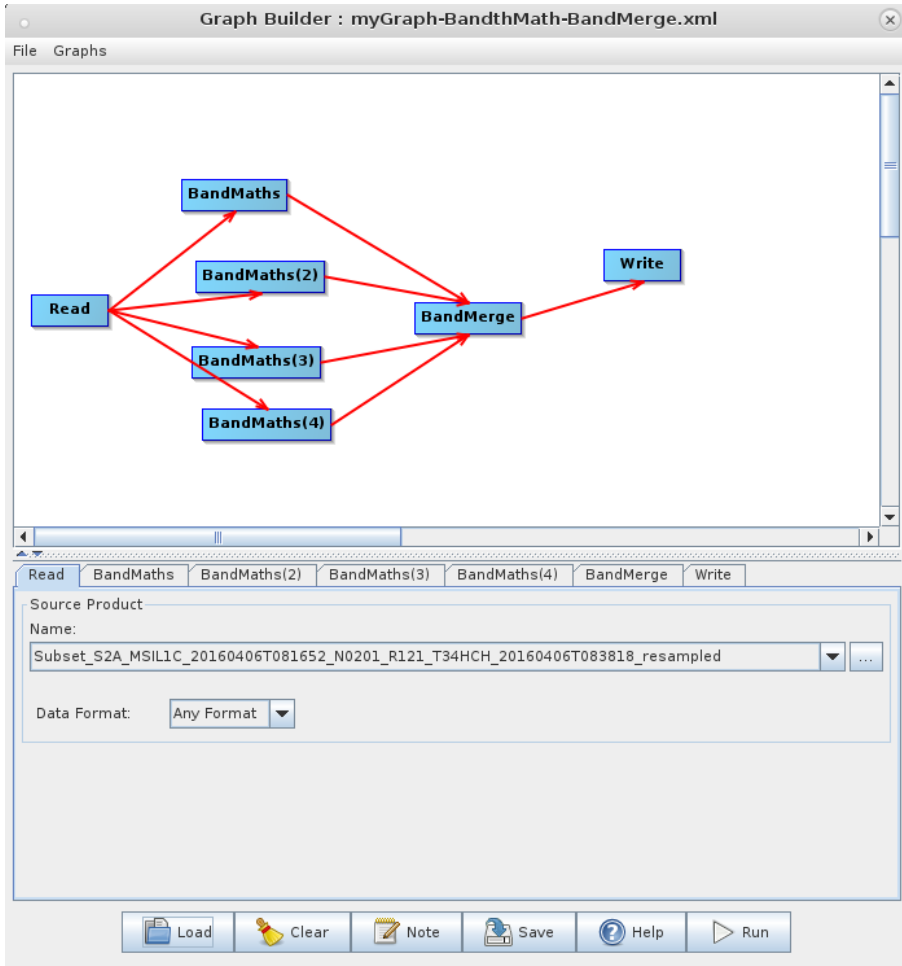
```

Expressions.txt - Mousepad
File Edit Search View Document Help
1 Download Sentinel-2 products
2 aria2c --http-user='username' --http-psswd='password' --check-certificate=false --max-
concurrent-downloads=2 -M products.meta4
3
4 ----Polygon WKT coordinates for Subset-----
5 POLYGON (((19.061834340155283 -33.955691701708375, 19.379564169402002 -33.96028594353146,
6 19.376352000158878 -34.12895277789442, 19.057993224051753 -34.124329459334305,
7 19.061834340155283 -33.955691701708375)))
8
9 -----Expressions used in Band Math operators to create water indices:-----
10 NDWI = (B3 - B8) / (B3 + B8)
11 MNDWI = (B3 - B11) / (B3 + B11)
12 MNDWI5 = (B8 - B4) / (B8 + B4)
13 AWEI = B2 + 2.5 * B3 - 1.5 * (B8 + B11) - 0.25 * B12
14
15 -----Expression used to create water mask -----
16 if (MNDWI >= 0 or NDWI >= 0 or MNDWI5 <= 0 or AWEI >= 0) then 1 else 0
17

```

Fórmulas para ser aplicadas

Flujo de trabajo para aplicar los Índices radiométricos del agua



BandMaths

Target Band: NDWI
 Target Band Type: float32
 Band Unit:
 No-Data Value: 0.0
 Expression: $(B3 - B8)/(B3 + B8)$

BandMaths(3)

Target Band: MNDWI5
 Target Band Type: float32
 Band Unit:
 No-Data Value: 0.0
 Expression: $(B8 - B4)/(B8 + B4)$

BandMaths(2)

Target Band: MNDWI
 Target Band Type: float32
 Band Unit:
 No-Data Value: 0.0
 Expression: $(B3 - B11)/(B3 + B11)$

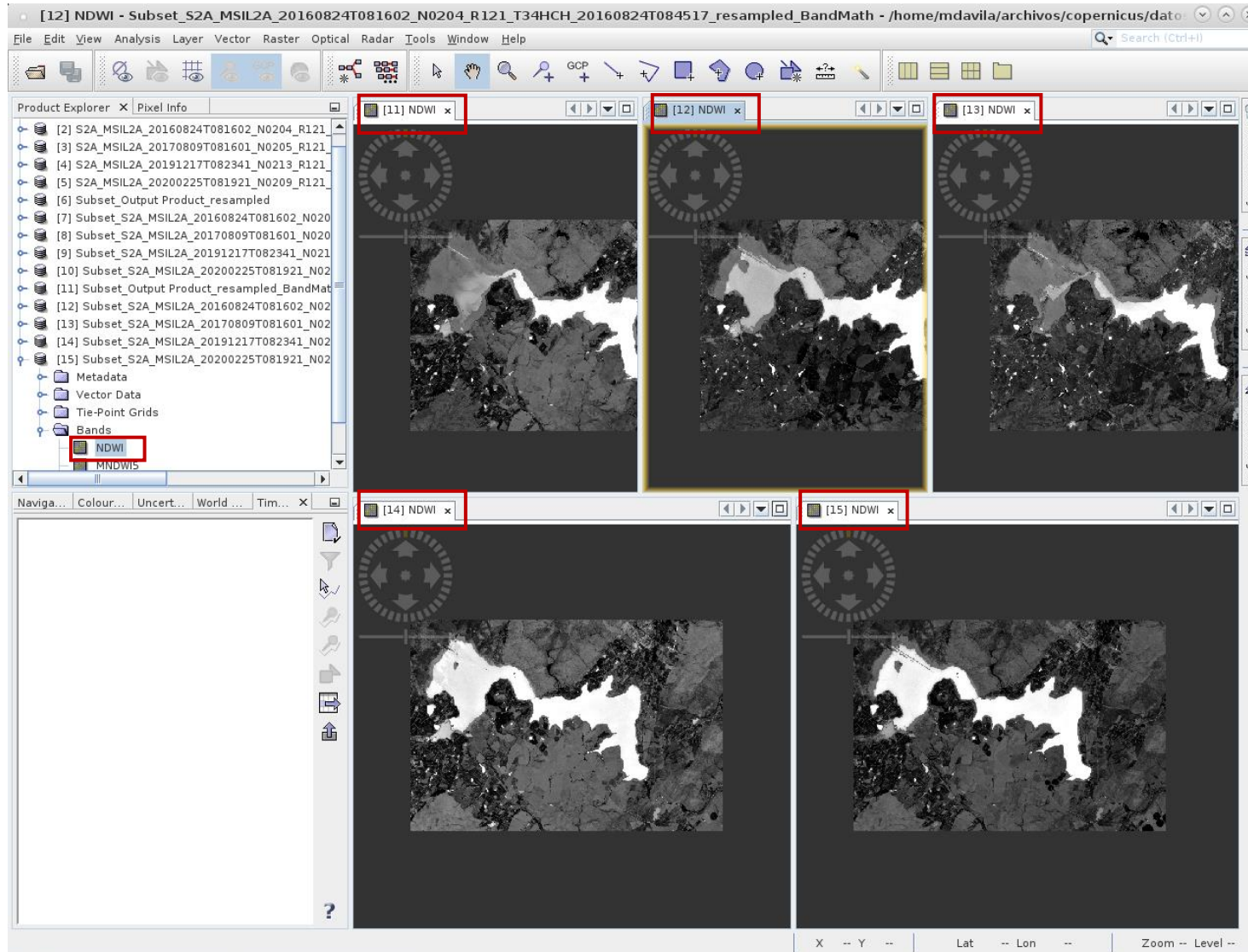
BandMaths(4)

Target Band: AWEI
 Target Band Type: float32
 Band Unit:
 No-Data Value: 0.0
 Expression: $B2 + 2.5 * B3 - 1.5 * (B8 + B11) - 0.25 * B12$

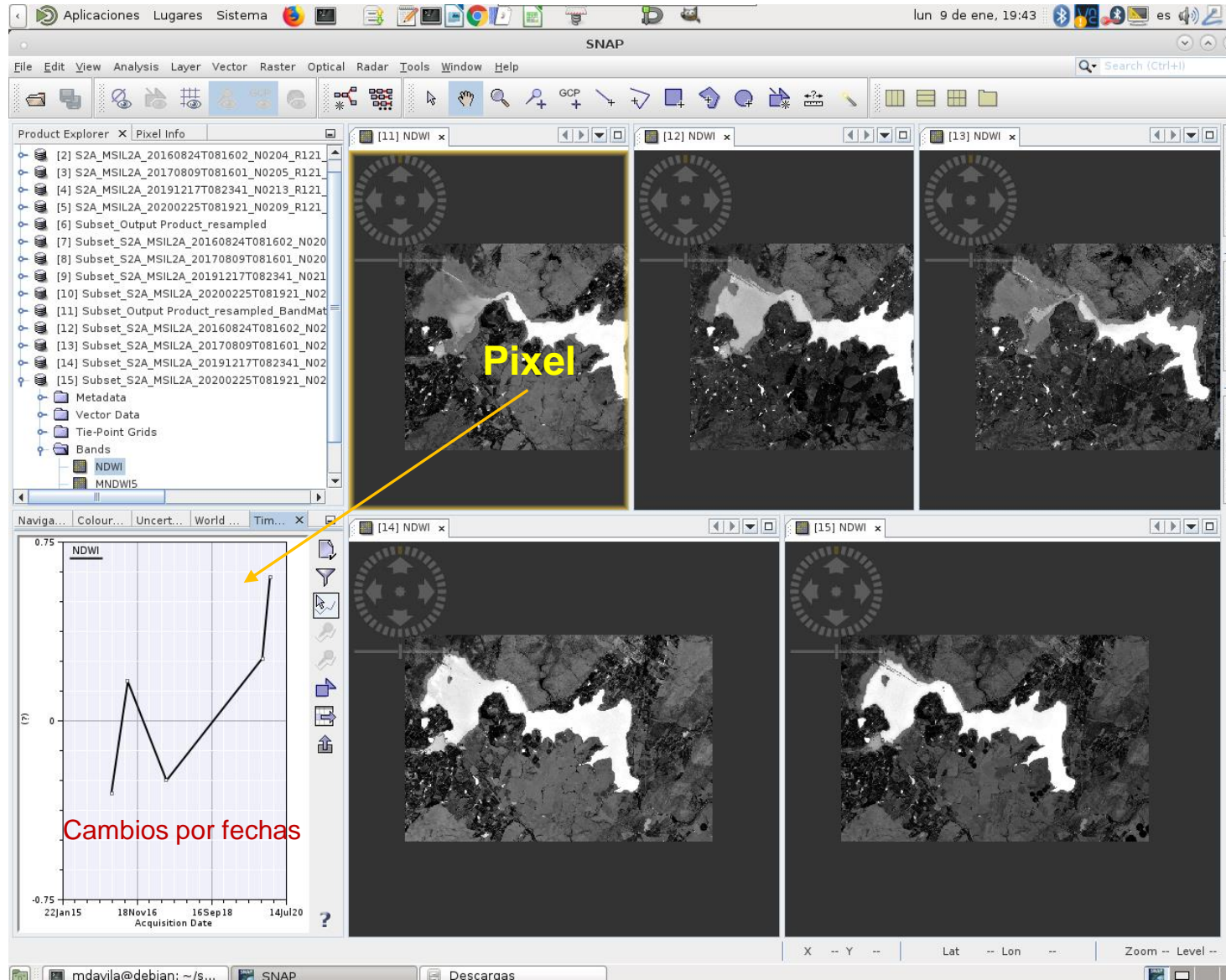
BandMerge

Source Bands:
 NDWI::Subset_S2A_MSIL1C_20160406T081652_N0201_R121_T34HCH_20160406T083818_resampled_BandMath
 MNDWI::Subset_S2A_MSIL1C_20160406T081652_N0201_R121_T34HCH_20160406T083818_resampled_BandMath
 MNDWI5::Subset_S2A_MSIL1C_20160406T081652_N0201_R121_T34HCH_20160406T083818_resampled_BandMath
 AWEI::Subset_S2A_MSIL1C_20160406T081652_N0201_R121_T34HCH_20160406T083818_resampled_BandMath

Series de tiempo



Series de tiempo analizando NDWI



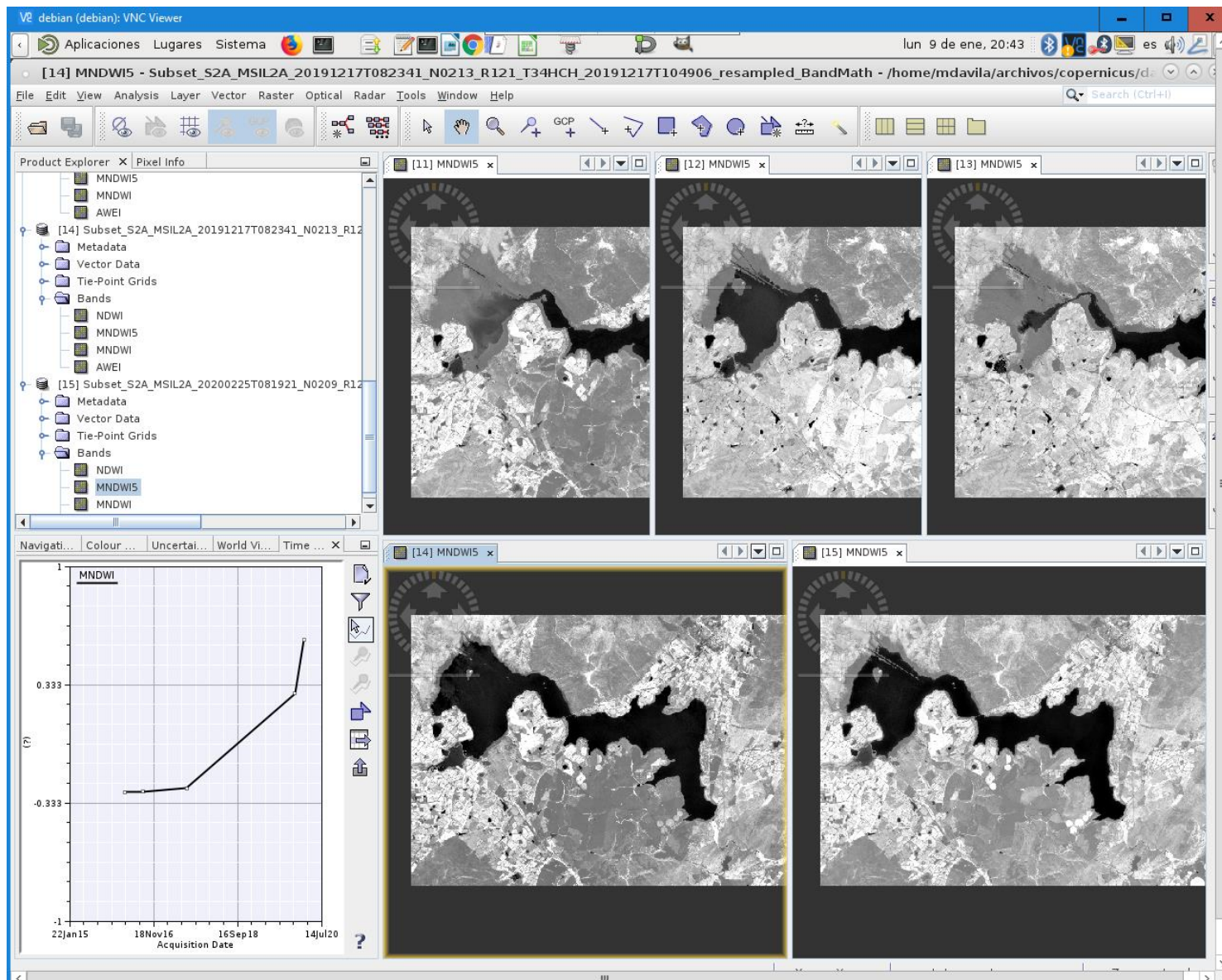
Para cada mapa aparecen los índices radiométricos:

NDWI
MNDWI
MNDWI5
AWEI

Cada uno de ellos mostrará gráficamente los niveles de agua cuando se use (ver adelante) la opción de series de tiempo de acuerdo a las siguientes características:

NDWI: indica agua si el índice es ≥ 0
MNDWI: indica agua si el índice es ≥ 0
MNDWI5: indica agua si el índice es ≤ 0
AWEI: indica agua si el índice es ≥ 0

Series de tiempo analizando NDWI5



Para cada mapa aparecen los índices radiométricos:

NDWI
MNDWI
MNDWI5
AWEI

Cada uno de ellos mostrará gráficamente los niveles de agua cuando se use (ver adelante) la opción de series de tiempo de acuerdo a las siguientes características:

NDWI: indica agua si el índice es ≥ 0
MNDWI: indica agua si el índice es ≥ 0
MNDWI5: indica agua si el índice es ≤ 0
AWEI: indica agua si el índice es ≥ 0

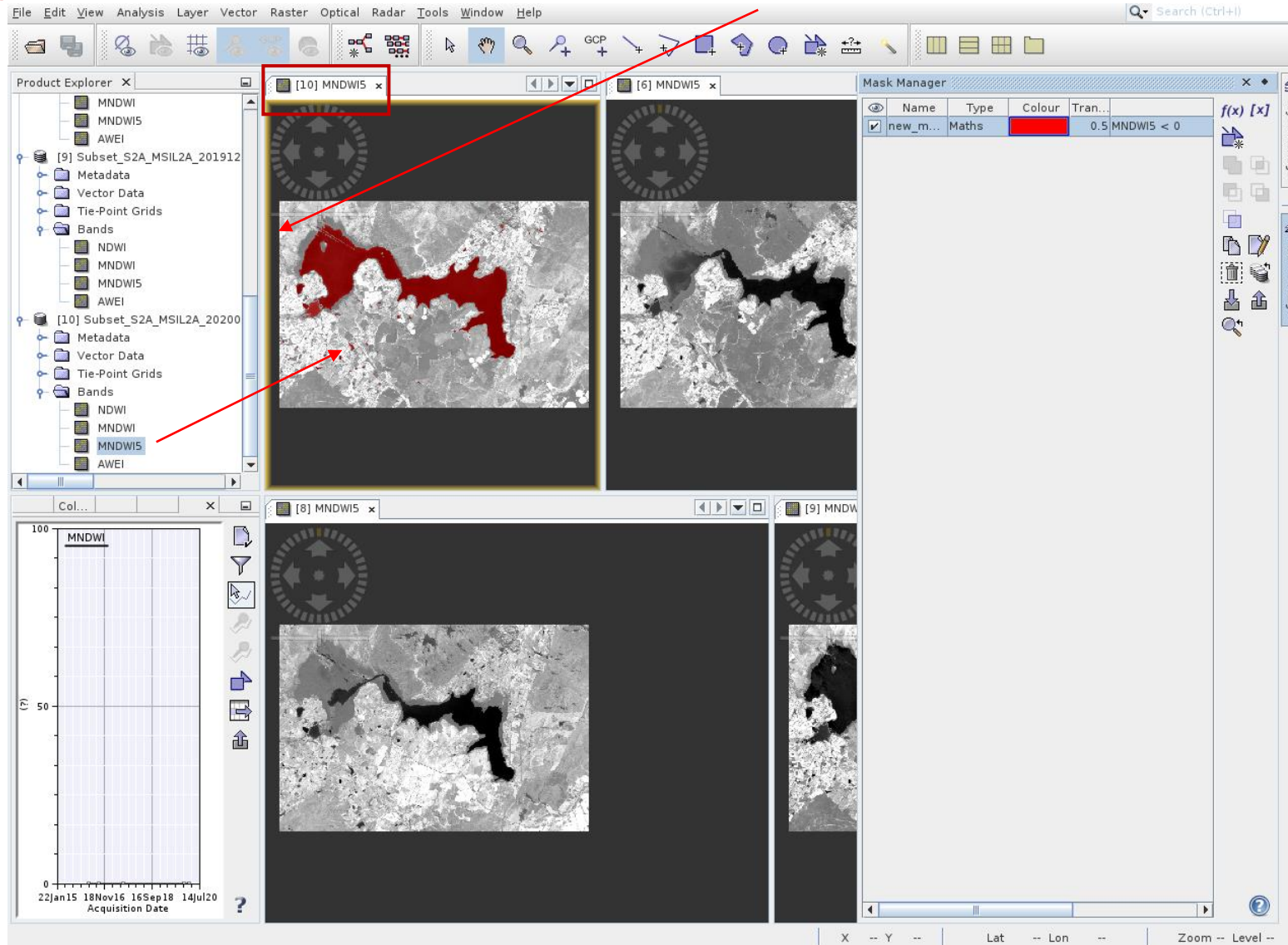
Presentar agua de manera explícita

The screenshot shows the SNAP (Scientific Data Processing) software interface. A dialog box titled "New Logical Band Maths Expression" is open, with the expression $MNDWI5 < 0$ entered in the "Expression:" field. The dialog also shows a list of data sources including NDWI, MNDWI, MNDWI5, and AWEI. In the background, there are satellite imagery windows and a time-series plot of MNDWI values from 2015 to 2020. A blue arrow points to the time-series plot.

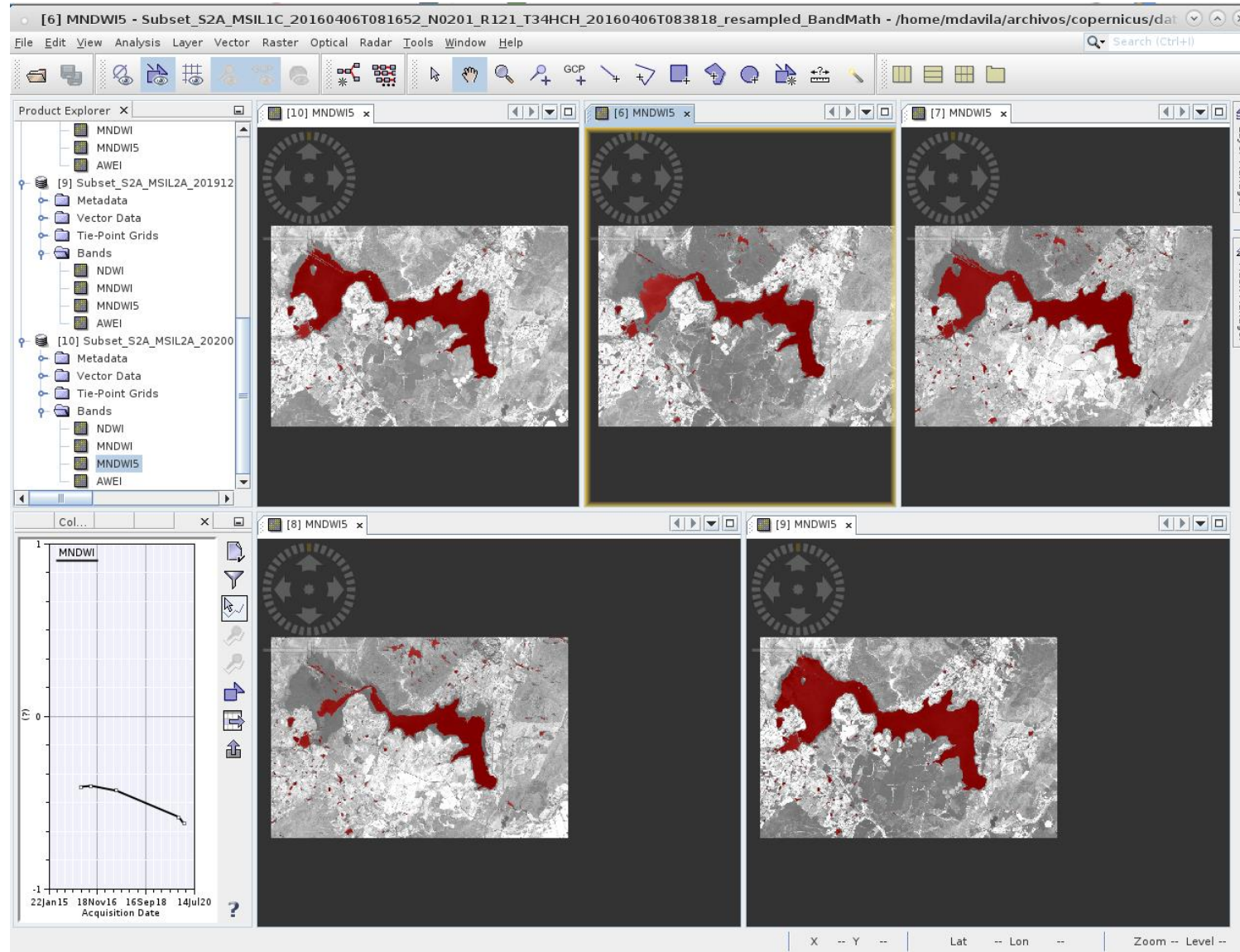
$MNDWI5 < 0$

Con la opción de **series de tiempo** es posible revisar cada pixel desde el punto de vista de los resultados de los índices radiométricos

Ejemplo del resultado al aplicar el índice radiométrico

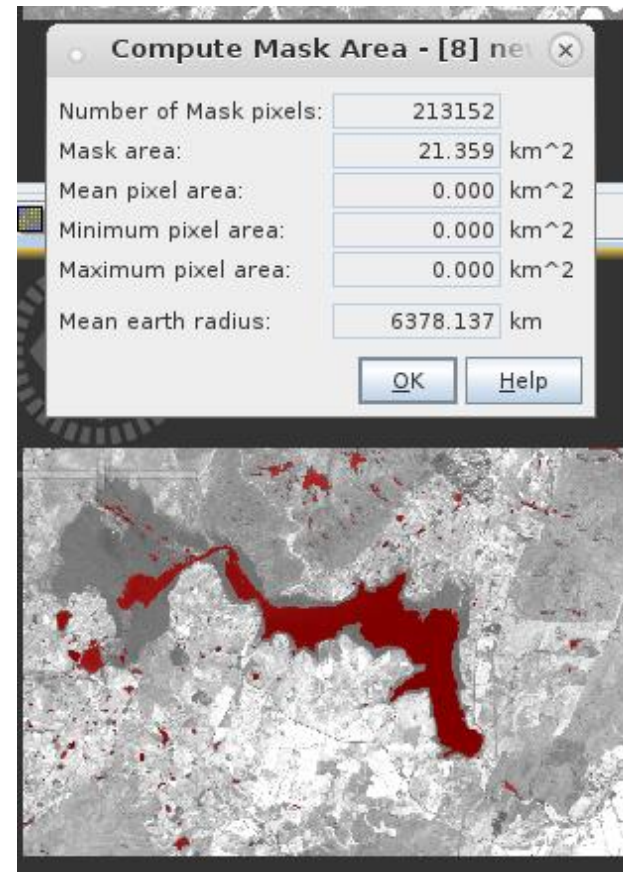
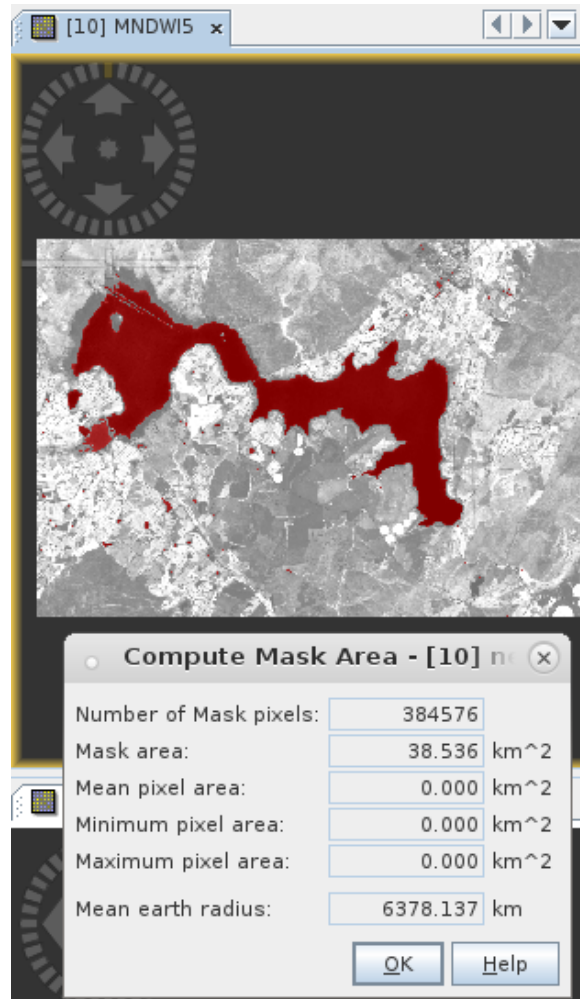


Ejemplo del índice radiométrico MNDWI5 aplicado a todos los mapas



Raster/Masks/Mask Area

Cálculo de áreas utilizando SNAP



Proceso para aplicar todos los índices radiométricos y escoger los valores que presenten solo agua

The screenshot shows the Graph Builder interface with a workflow consisting of three nodes: Read, BandMaths, and Write, connected by red arrows. The BandMaths node is selected, and its configuration panel is visible. The configuration includes:

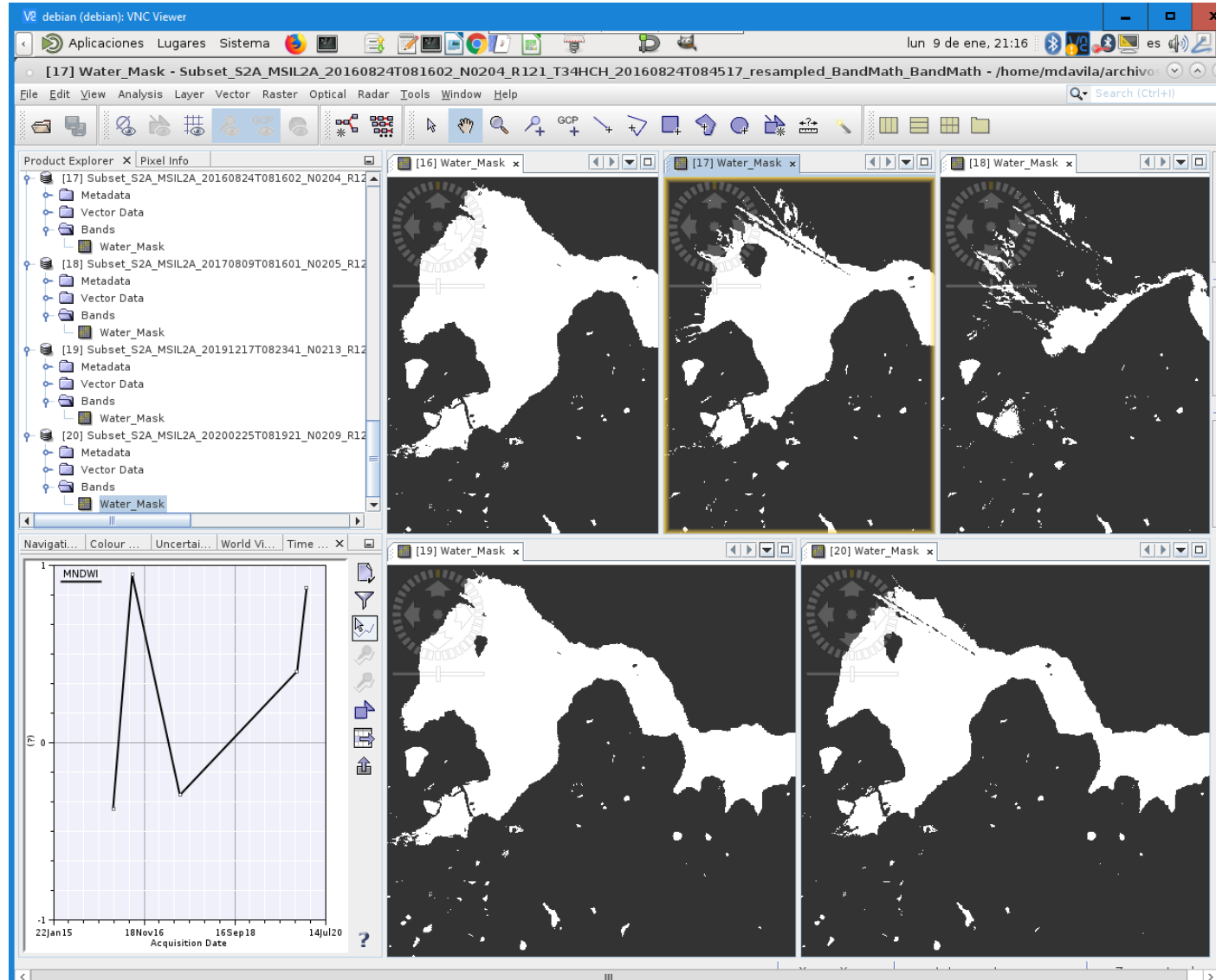
- Target Band: Water_Masks
- Target Band Type: float32
- Band Unit: (empty)
- No-Data Value: 0.0
- Expression: `if (MNDWI >=0 or NDWI >=0 or MNDWI5 <=0 or AWEI >=0) Then 1 else 0`

A red error message "Expression is invalid." is displayed at the bottom of the configuration panel. The bottom toolbar contains buttons for Load, Clear, Note, Save, Help, and Run.

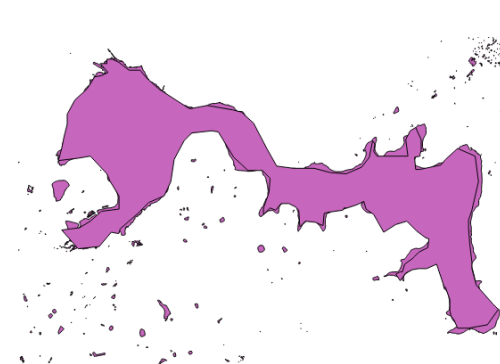
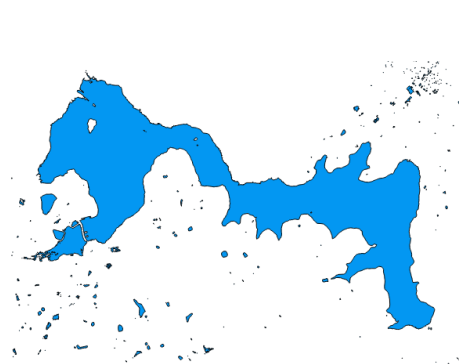
NDWI: indica agua si el índice es ≥ 0
MNDWI: indica agua si el índice es ≥ 0
MNDWI5: indica agua si el índice es ≤ 0
AWEI: indica agua si el índice es ≥ 0

If (MNDWI ≥ 0 or NDWI ≥ 0 or MNDWI5 ≤ 0 or AWEI ≥ 0) then 1 else 0

Water_Mask aplicado: solo agua



Cambios en los niveles de agua





FIN