



# Evaluación de los Peligros de Derrumbes Antes y Durante un Evento

Thomas Stanley, Universities Space Research Association, Goddard Earth Sciences Technology and Research, NASA Goddard Space Flight Center

26 de agosto de 2021



# Esquema de la Capacitación

Evaluación de Impactos  
Antes y Después de una  
Tormenta  
18 de agosto de 2021



<https://phys.org/news/2019-12-philippines-homes.html>

Evaluación del Aumento del  
Nivel del Mar en Escala  
Regional a Local  
24 de agosto de 2021



[https://e360.yale.edu/features/rising\\_waters\\_how\\_fast\\_and\\_how\\_far\\_will\\_sea\\_levels\\_rise](https://e360.yale.edu/features/rising_waters_how_fast_and_how_far_will_sea_levels_rise)

**Evaluación del Peligro de  
Derrumbes**

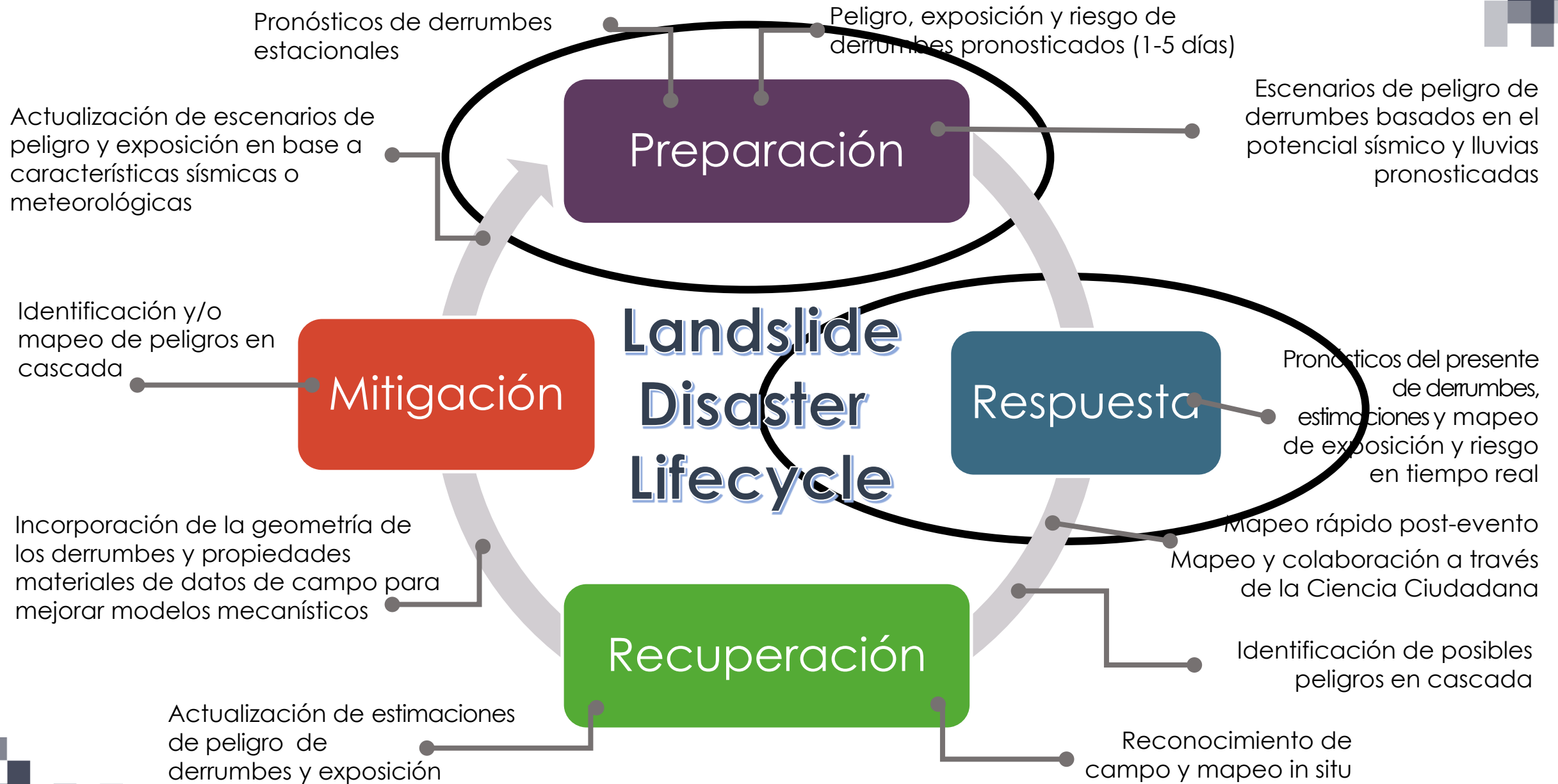
**26 de agosto de 2021**



<https://tweathercenter.com/severe-weather/landslides/>







# Los Deslizamientos de Tierra son un Gran Problema

## Y Tienen Varias Causas

**TRIGGER**  
**Glacial Melt**  
**Snow Melt**  
(MODIS, Landsat, ASTER, Hydrological modeling inputs)

**Heavy Precipitation**  
(TRMM/GPM, WRF Forecast)

**Earthquakes**  
(USGS catalogs, SAR Deformation)

**Infrastructure**  
(Open Street Map, National Inventories, and databases)

**Landslides**

earthquake.usgs.gov/earthquakes/eventpage/us6000eyfk/ground-failure/summary

Felt Report - Tell Us!

Did You Feel It?

ShakeMap

PAGER

Ground Failure

Technical

Origin

Moment Tensor

Waveforms

Download Event KML

View Nearby Seismicity

Earthquakes

Hazards

Data & Products

Learn

Monitoring

Research

**Summary** About

**Landslides**

Estimated Area Exposed to Hazard

Little or no Landsliding is expected, but some landslides could have occurred in highly susceptible areas.

Estimated Population Exposure

The number of people living near areas that could have produced landslides in this earthquake is low, but landslide damage or fatalities are still possible in highly susceptible areas. This is not a direct estimate of landslide fatalities or losses.

**Liquefaction**

Estimated Area Exposed to Hazard

Little or no liquefaction is expected, but some liquefaction could have occurred in highly susceptible areas.

Estimated Population Exposure

The number of people living near areas that could have produced liquefaction in this earthquake is low, but liquefaction damage or fatalities are still possible in highly susceptible areas. This is not a direct estimate of liquefaction fatalities or losses.

VIEW LANDSLIDES MAP

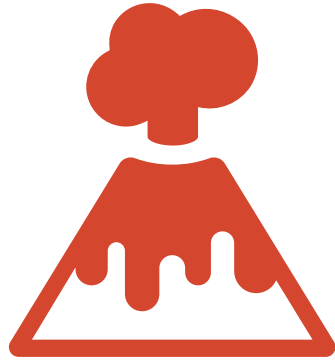
VIEW LIQUEFACTION MAP





# Algunos Pequeños Estados Insulares Están Altamente Expuestos a los Derrumbes

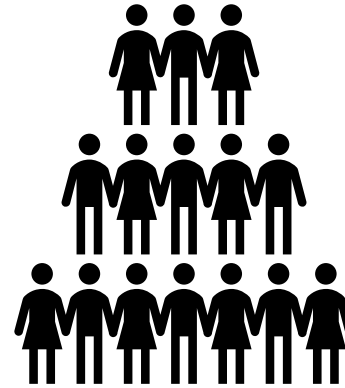
Debido a una Combinación Común de factores



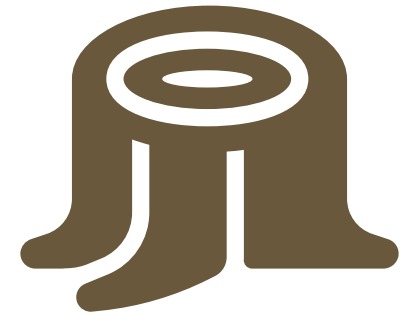
Suelos Volcánicos  
y Pendientes  
Empinadas



Ciclones  
Tropicales  
Intensos

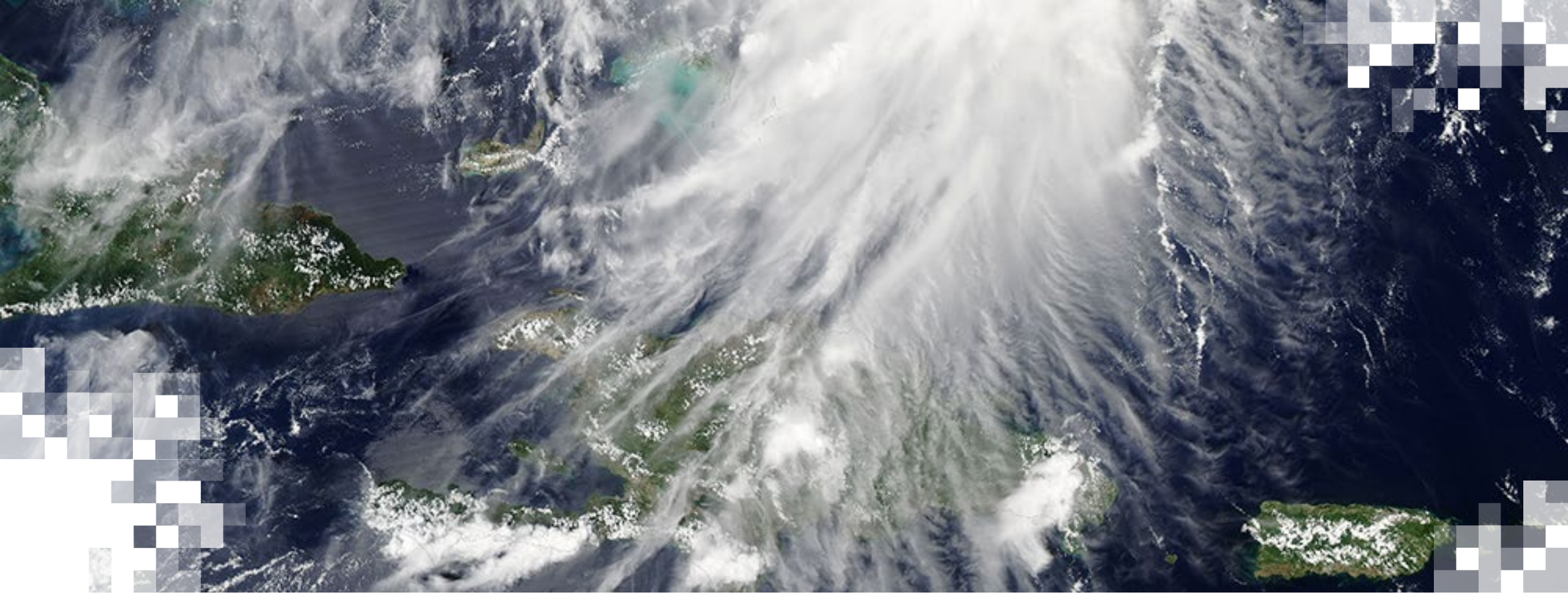


Población  
Densa



Deforestación





Algunos Recursos para Evaluar el Peligro de  
Derrumbes Antes de un Evento



# Global Landslide Catalog (GLC)



En la Página de Landslide Viewer ([landslides.nasa.gov/viewer](http://landslides.nasa.gov/viewer))

The screenshot shows the NASA Landslide Viewer interface. At the top, it says "NASA Landslide Viewer" and "Download the full Landslide Catalog". There are navigation icons for home, search, and other functions. A search bar contains the text "Find address or place". The map displays the Caribbean region with numerous orange circular markers indicating landslide locations. A popup window is open over the map, showing details for an event on October 21, 2008. The popup contains the following information:

October 21, 2008 (Fatalities: )	
Name of Information Source	nationnews
Link to Information Source	<a href="#">More info</a>
Event ID	857
Event Date	October 21, 2008
Event Time (approximate)	
Event Title	East Coast Road (below Cambridge, St Joseph)
Event Description	Tonnes of mud came down the hills. Some spilled onto the highway, making it impassable, while the majority went out to sea:
Zoom to	...



# Global Landslide Catalog (GLC)



En la Página de Landslide Viewer ([landslides.nasa.gov/viewer](https://landslides.nasa.gov/viewer))

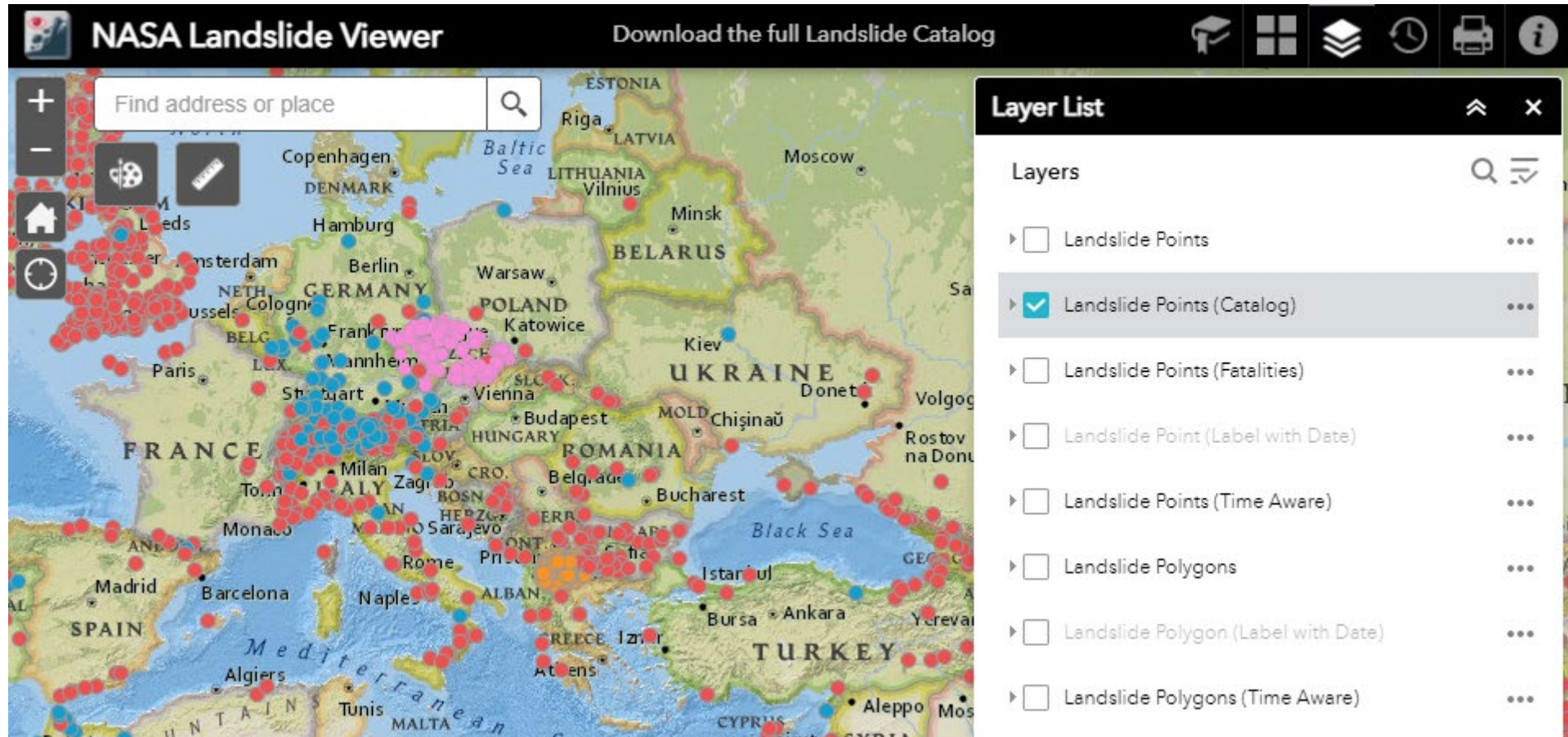
The screenshot shows the NASA Landslide Viewer web application. At the top, there's a header with the NASA logo, the text "NASA Landslide Viewer", and a link to "Download the full Landslide Catalog". Below the header is a search bar with the placeholder text "Find address or place". On the left side, there are navigation icons for zooming in (+), zooming out (-), home, and refresh. The main map area shows an aerial view of a landscape with a yellow highlighted area. A popup window is open over this area, displaying event details for a landslide that occurred on December 14, 2016. The popup includes the source (The Sacramento Bee), event ID (10,230), event date, event time (approximate), event title, and a description. A "Zoom to" link is at the bottom of the popup. On the right side, there is a "Basemap Gallery" panel with a grid of map style options: Dark Gray Canvas, Imagery (selected), Imagery with Labels, Light Gray Canvas, National Geographic, Oceans, OpenStreetMap, Streets, Terrain with Labels, and Topographic.





# Más del “Cooperative Open Online Landslide Repository” (COOLR)

En la Página de Landslide Viewer ([landslides.nasa.gov/viewer](https://landslides.nasa.gov/viewer))

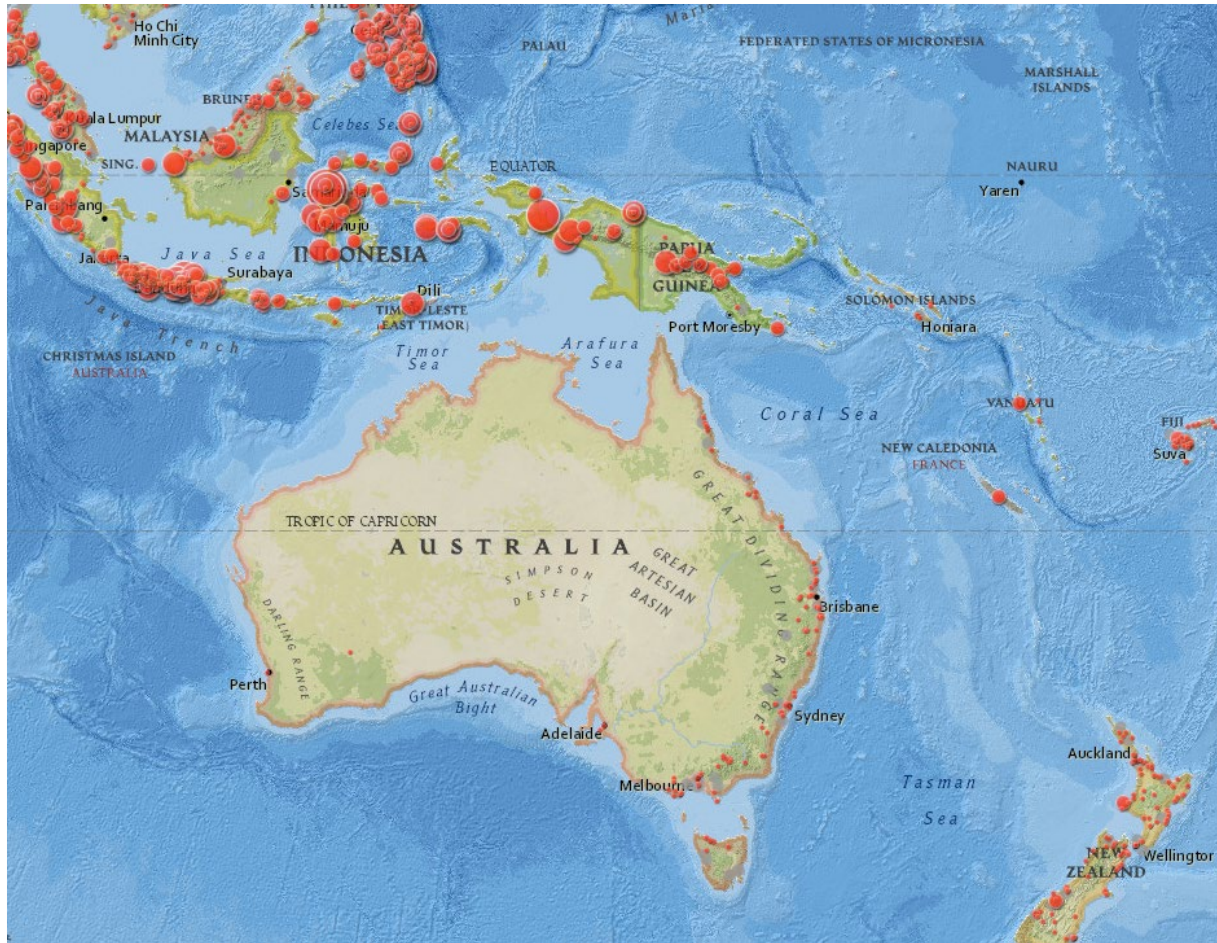




# Muertes y Cronología



En la Página de Landslide Viewer ([landslides.nasa.gov/viewer](https://landslides.nasa.gov/viewer))





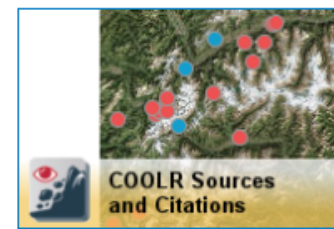
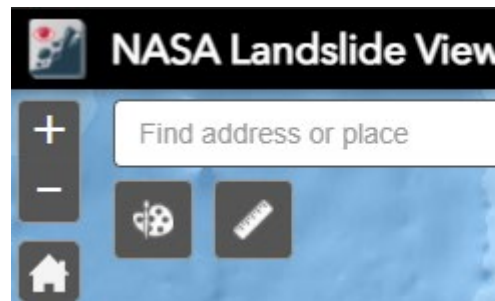
# Descargue Todos los Datos En la Página de Landslide View

## Global Landslide Catalog Downloadable Products

The Cooperative Open Online Landslide Repository (COOLR) is a worldwide database of landslide events from NASA, scientists, and citizen scientists. You can download the COOLR catalog as a file geodatabase (.gdb), shapefiles (.shp), or comma-separated values (.csv). Learn more about the data and citizen science at [landslides.nasa.gov](https://landslides.nasa.gov).

### Tags

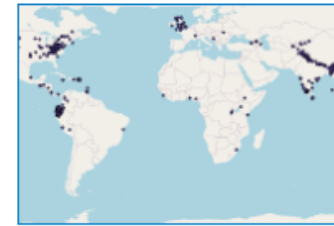
617 catalog coolr csv file  
geodatabase glc global  
landslide landslide inventory  
nasa point polygon shapefile



### COOLR Sources and Citations (CSV)

CSV

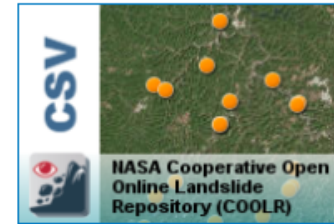
Important citation information about the landslide catalogs within the Cooperative Open Online Landslide Repository.



### Global Gridded Landslide Inventory

CSV

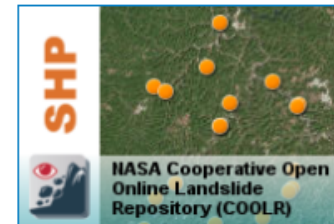
Count of landslides mapped within each 1-km grid cell. This file contains most of the landslide inventories used for training version 2.0 of the global landslide nowcast, now under review at *Frontiers in Earth Science*.



### NASA Global Landslide Catalog Points (CSV)

CSV

The NASA Cooperative Open Online Landslide Repository (COOLR) points, downloadable as a .csv file.



### NASA Global Landslide Catalog Points (Shapefile)

Shapefile

The NASA Cooperative Open Online Landslide Repository (COOLR) points, downloadable as a .shp file.



### NASA Global Landslide Catalog Polygons (CSV)

CSV

The NASA Cooperative Open Online Landslide Repository (COOLR) polygons, downloadable as a .csv file.



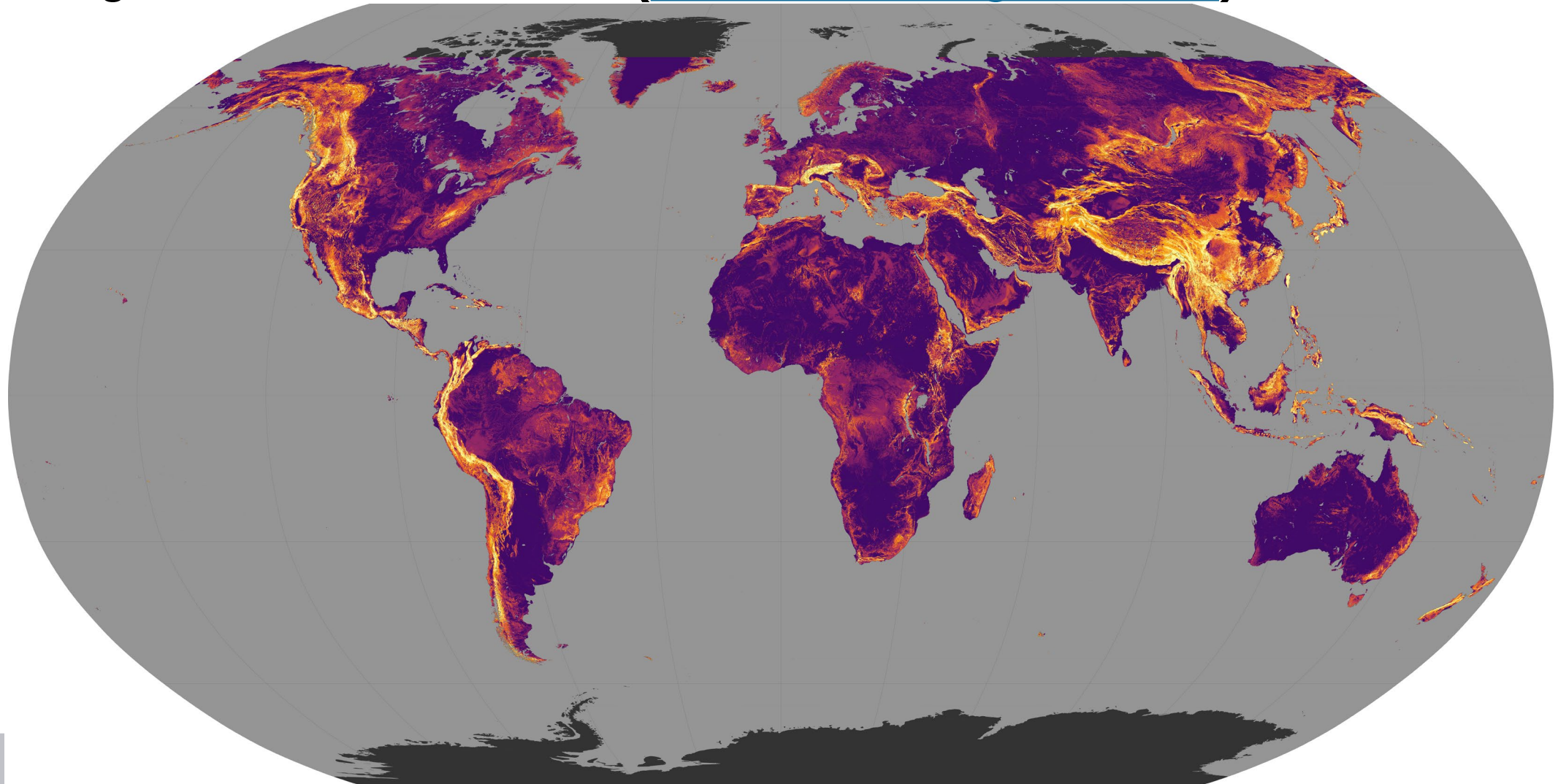
### NASA Global Landslide Catalog Polygons (Shapefile)

Shapefile

The NASA Cooperative Open Online Landslide Repository (COOLR) polygons, downloadable as a .shp file.

# Mapa de Susceptibilidad a Derrumbes

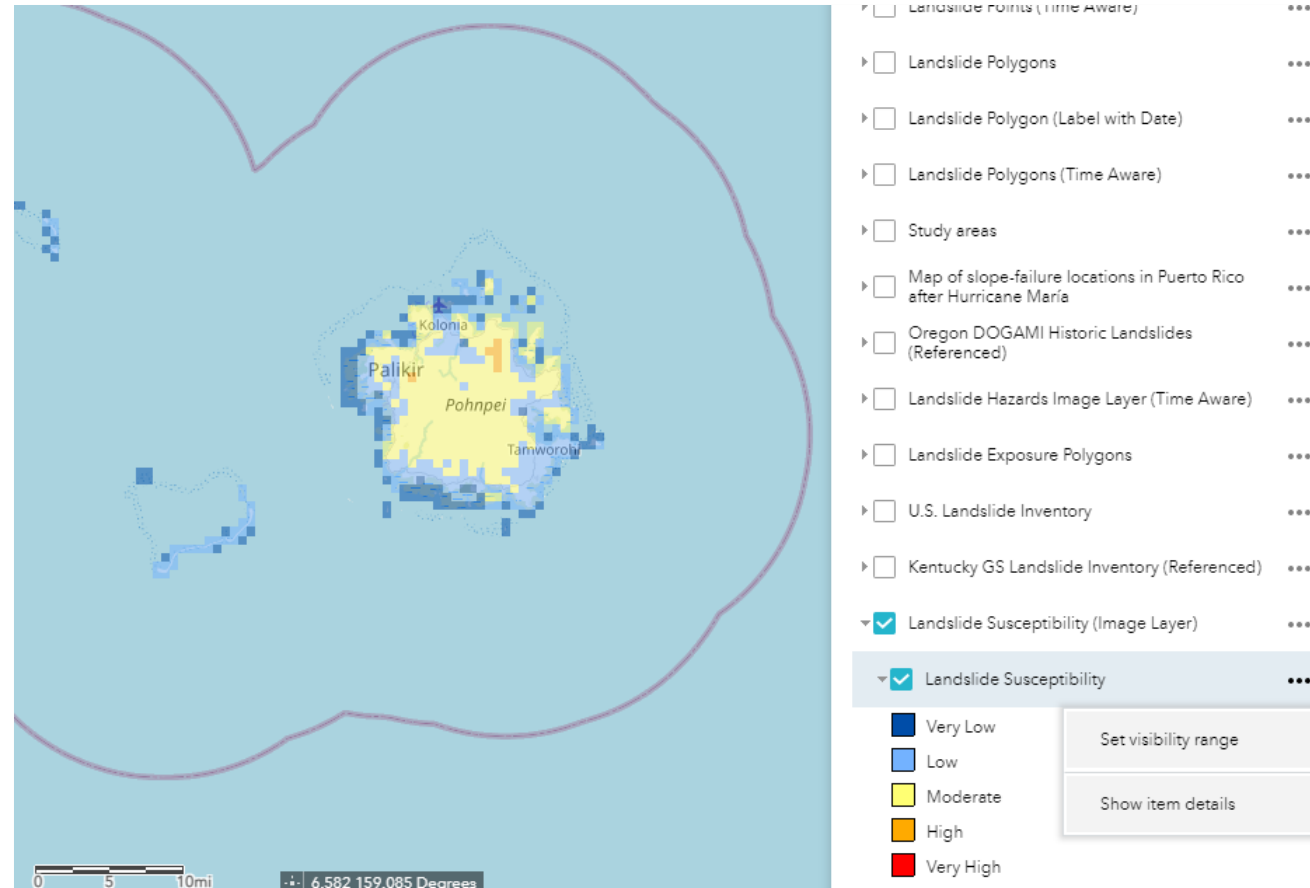
En la Página de Landslide Viewer ([landslides.nasa.gov/viewer](http://landslides.nasa.gov/viewer))

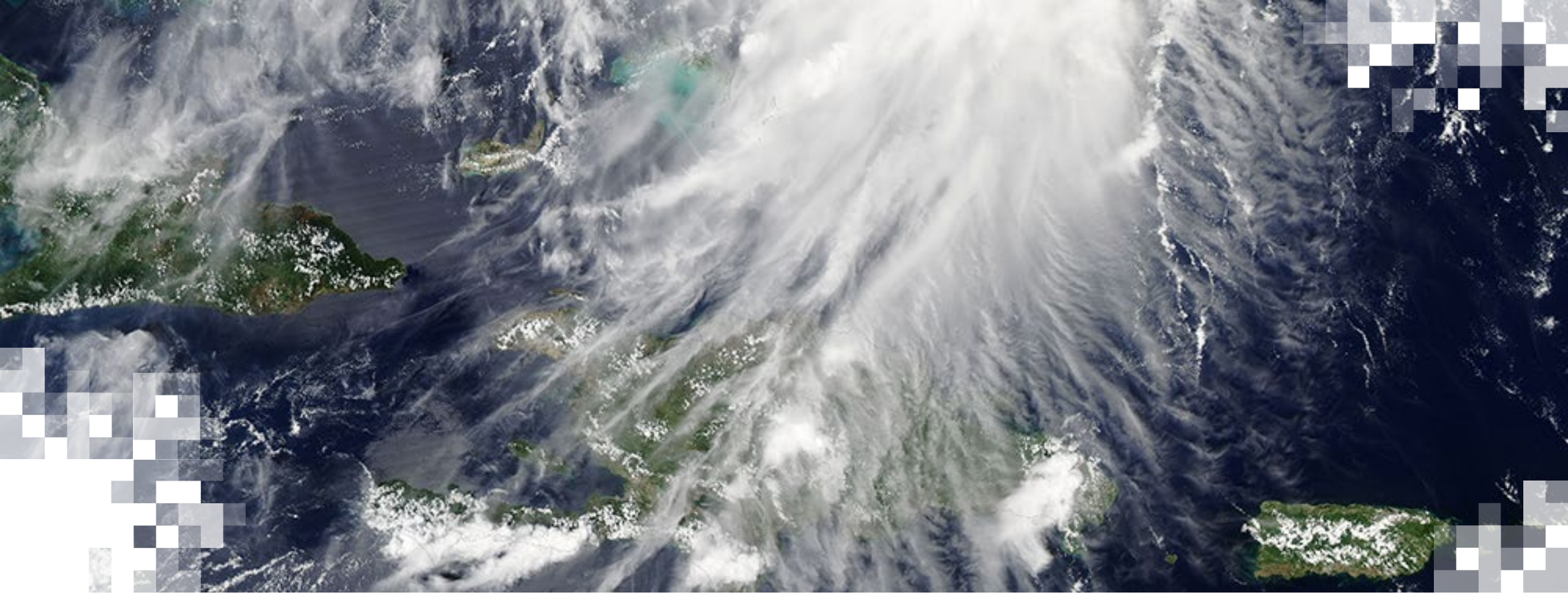




# Mapa de Susceptibilidad a Derrumbes

En la Página de Landslide Viewer ([landslides.nasa.gov/viewer](https://landslides.nasa.gov/viewer))





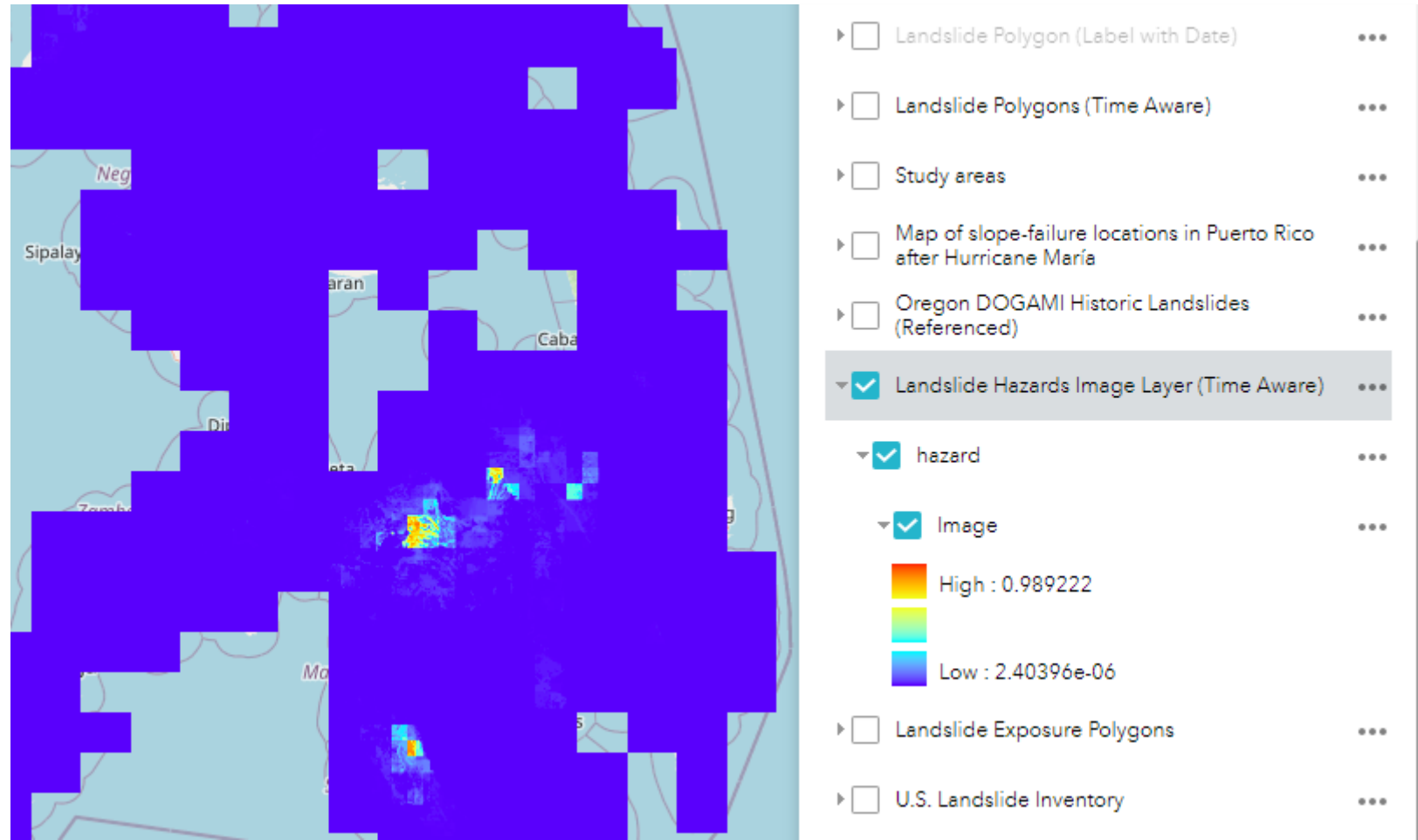
Algunos Recursos para Evaluar el Peligro de  
Derrumbes Durante un Evento



# Global Landslide Nowcast (Pronóstico del Presente)

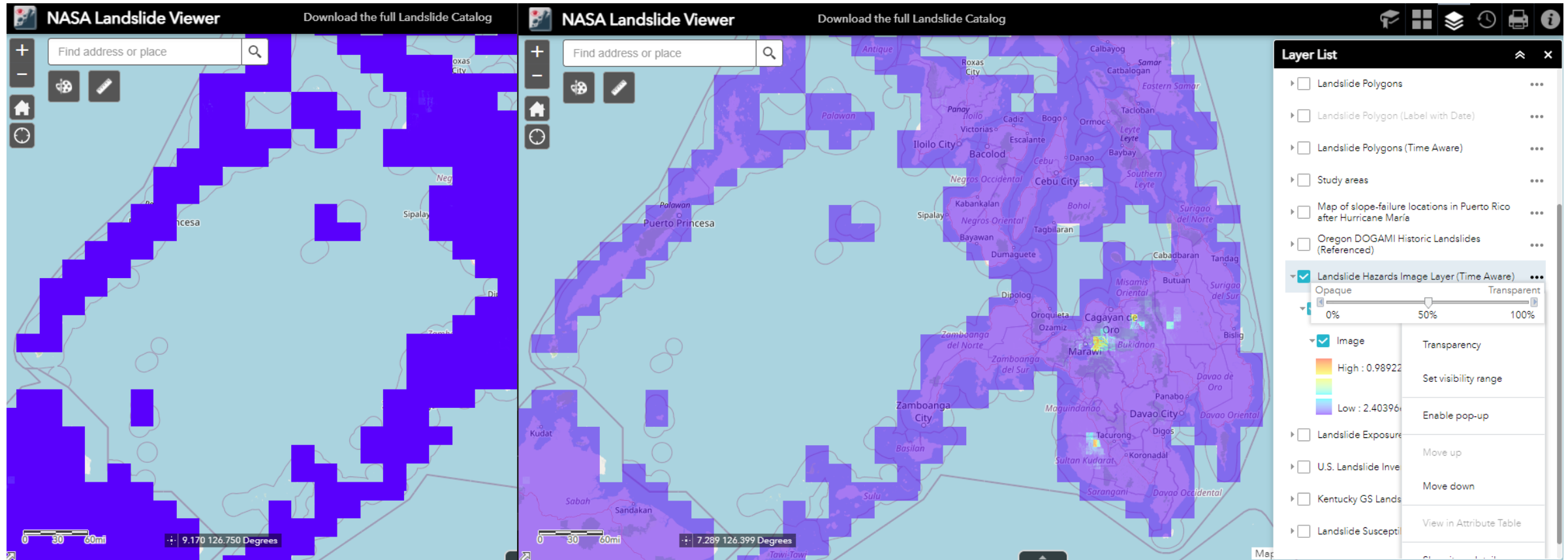


En Landslide Viewer ([landslides.nasa.gov/viewer](https://landslides.nasa.gov/viewer))



# Global Landslide Nowcast (Pronóstico del Presente)

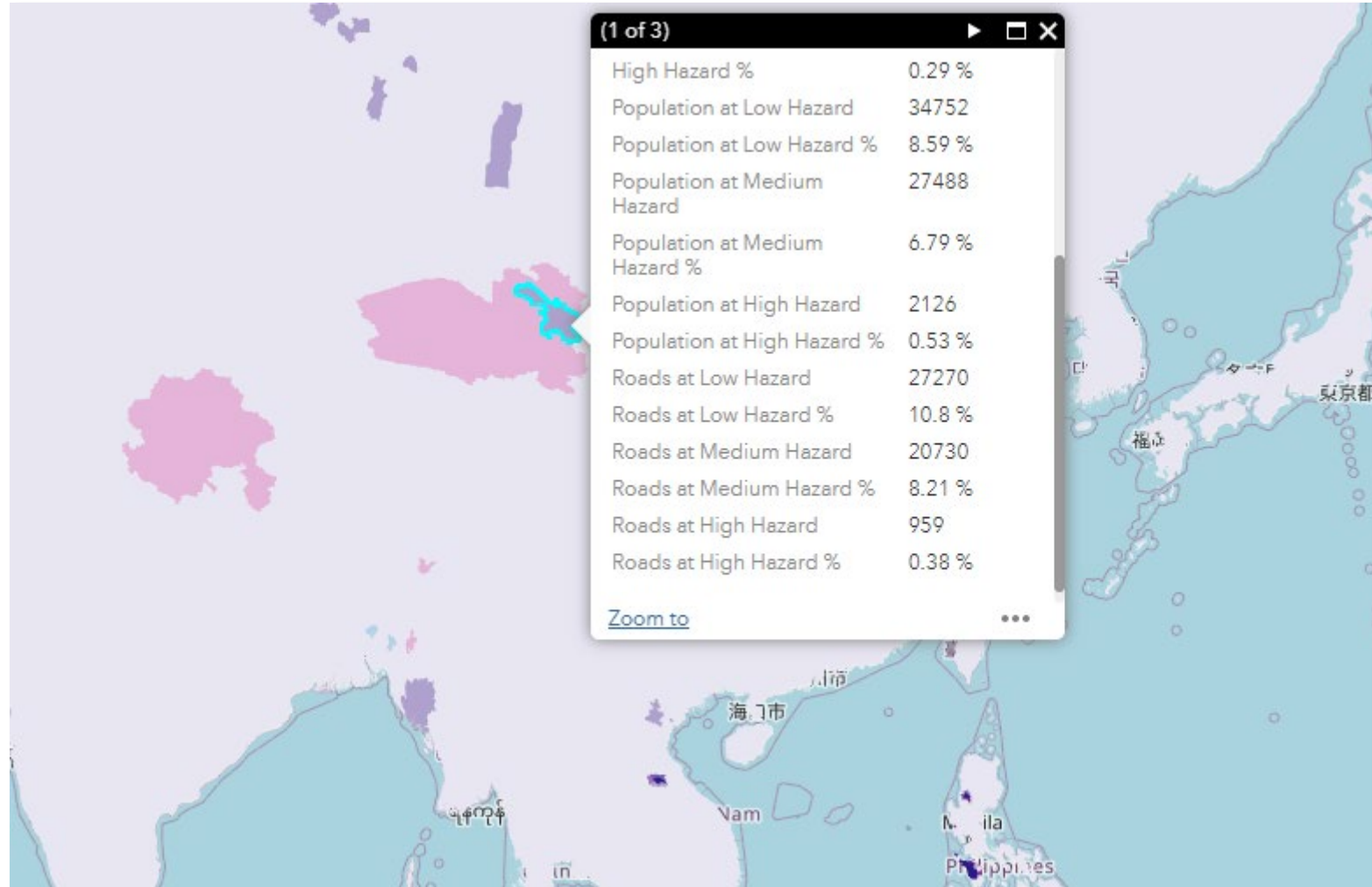
En Landslide Viewer ([landslides.nasa.gov/viewer](https://landslides.nasa.gov/viewer))





# Población y Caminos Expuestos del Global Landslide Nowcast

En Landslide Viewer ([landslides.nasa.gov/viewer](https://landslides.nasa.gov/viewer))






# Población y Caminos Expue Global Landslide Nowcast




















At Landslide Viewer ([landslides.na](https://landslides.nasa.gov)

maps.nccs.nasa.gov/download/landslides/nowcast/exposure/

## Index of /download/landslides/nowcas

<a href="#">Name</a>	<a href="#">Last modified</a>	<a href="#">Size</a>	<a href="#">Description</a>
 <a href="#">Parent Directory</a>			-
 <a href="#">admin2.zip</a>	26-May-2021 10:06	325M	
 <a href="#">csv/</a>	23-Jul-2021 10:30		-

## Index of /download/landslides/nowcast/exposure/csv

<a href="#">Name</a>	<a href="#">Last modified</a>	<a href="#">Size</a>	<a href="#">Description</a>
 <a href="#">Parent Directory</a>			-
 <a href="#">2021-04-11_1900.csv</a>	05-May-2021 13:31	4.3M	
 <a href="#">2021-04-14_0000.csv</a>	05-May-2021 13:31	4.4M	
 <a href="#">2021-04-26_1900.csv</a>	05-May-2021 13:31	4.4M	
 <a href="#">2021-04-27_0900.csv</a>	05-May-2021 13:31	4.4M	
 <a href="#">2021-05-03_0900.csv</a>	05-May-2021 13:31	4.5M	
 <a href="#">2021-05-03_1500.csv</a>	05-May-2021 13:47	4.5M	
 <a href="#">2021-05-04_0900.csv</a>	14-May-2021 11:27	4.5M	
 <a href="#">2021-05-12_0900.csv</a>	14-May-2021 11:27	4.4M	
 <a href="#">2021-05-12_1500.csv</a>	14-May-2021 11:27	4.4M	
 <a href="#">2021-05-13_1500.csv</a>	14-May-2021 16:31	4.4M	
 <a href="#">2021-05-13_2100.csv</a>	14-May-2021 22:30	4.4M	
 <a href="#">2021-05-14_0300.csv</a>	15-May-2021 04:30	4.4M	
 <a href="#">2021-05-14_0900.csv</a>	15-May-2021 10:30	4.4M	
 <a href="#">2021-05-14_1500.csv</a>	15-May-2021 16:30	4.4M	
 <a href="#">2021-05-14_2100.csv</a>	15-May-2021 22:30	4.4M	
 <a href="#">2021-05-15_0300.csv</a>	16-May-2021 04:30	4.4M	
 <a href="#">2021-05-15_0900.csv</a>	16-May-2021 10:30	4.4M	
 <a href="#">2021-05-15_1500.csv</a>	16-May-2021 16:30	4.4M	
 <a href="#">2021-05-15_2100.csv</a>	16-May-2021 22:30	4.5M	
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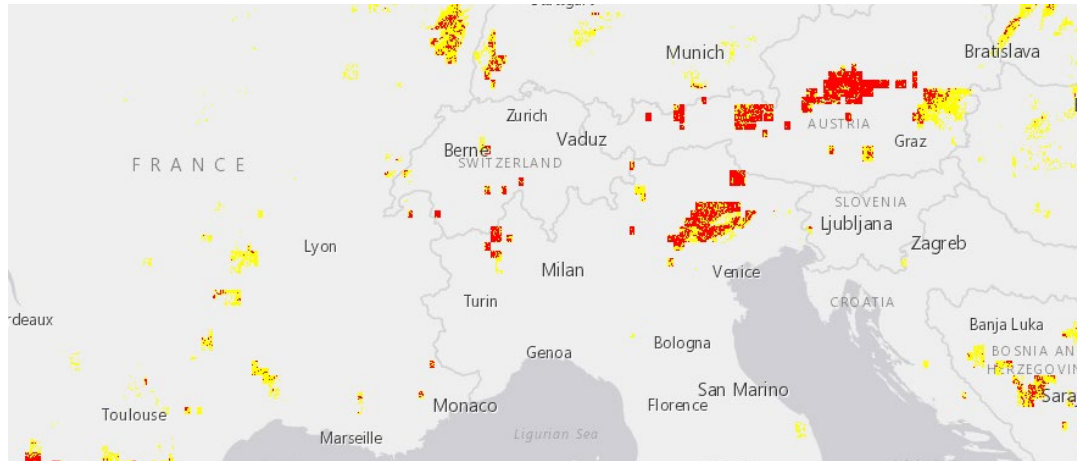
# Nuevas Funcionalidades del Global Landslide Nowcast (LHASA 2.0)

- Salidas probabilísticas, en vez de categóricas
  - Debido al uso de machine learning
  - Incorpora la humedad del suelo y la masa de la nieve
- Mayor precisión
- Análisis de exposición
- Sin embargo, la versión 1.1 aún se publica en las siguientes páginas <https://pmmmpublisher.pps.eosdis.nasa.gov/> y <https://gpm.nasa.gov/data/visualizations/precip-apps>.
- Ambas páginas permiten visualizar la salida del modelo “clásico”

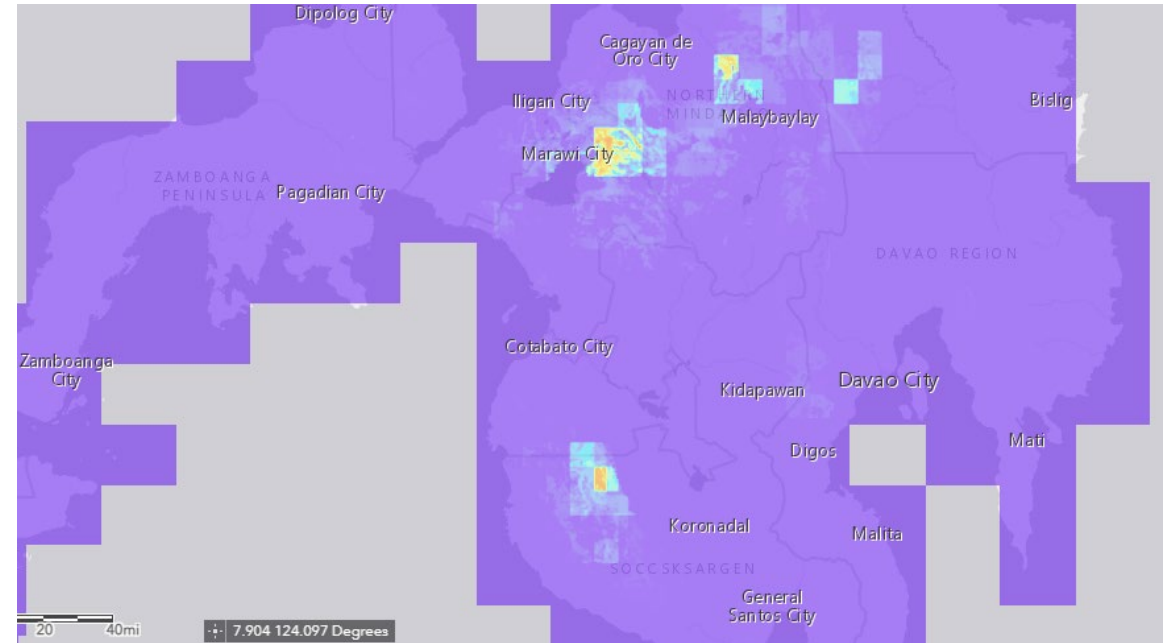


# El Modelo “Landslide Hazard Assessment for Situational Awareness\* (LHASA)”

## Versión 1.1



## Versión 2.0



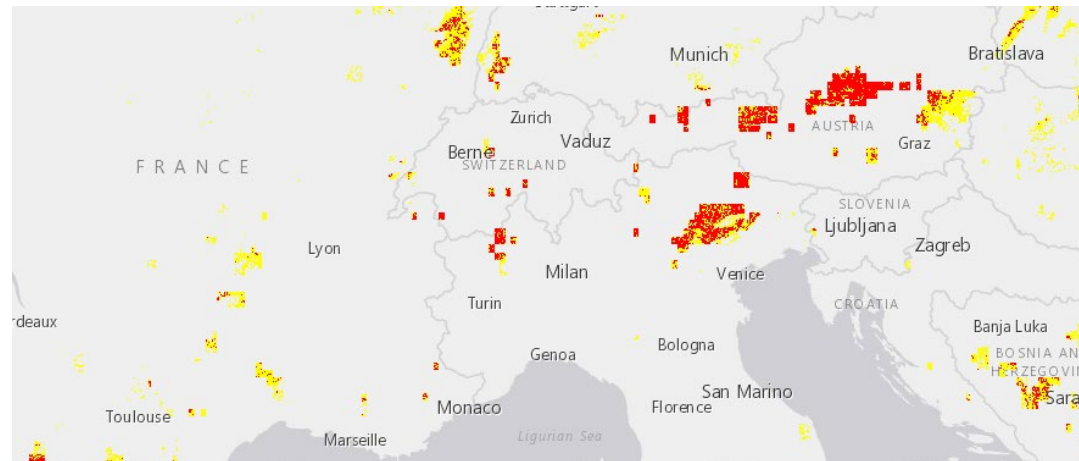
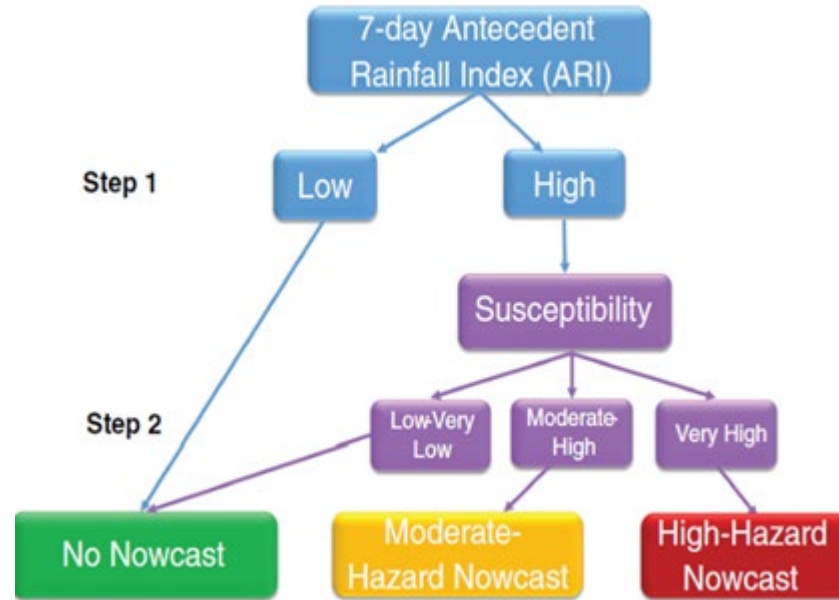
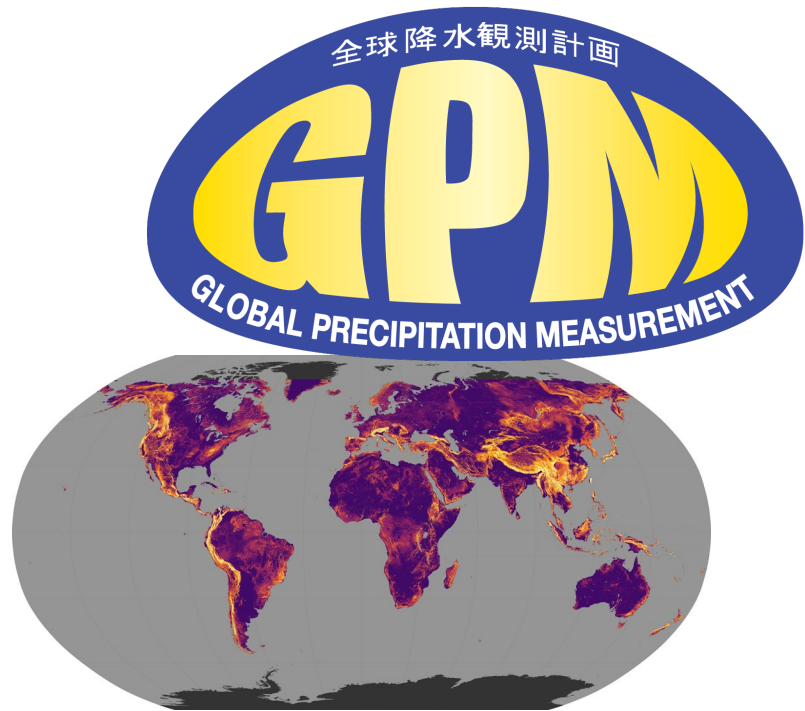
\*"Evaluación del Peligro de Derrumbes para una Concientización sobre la Situación" en inglés



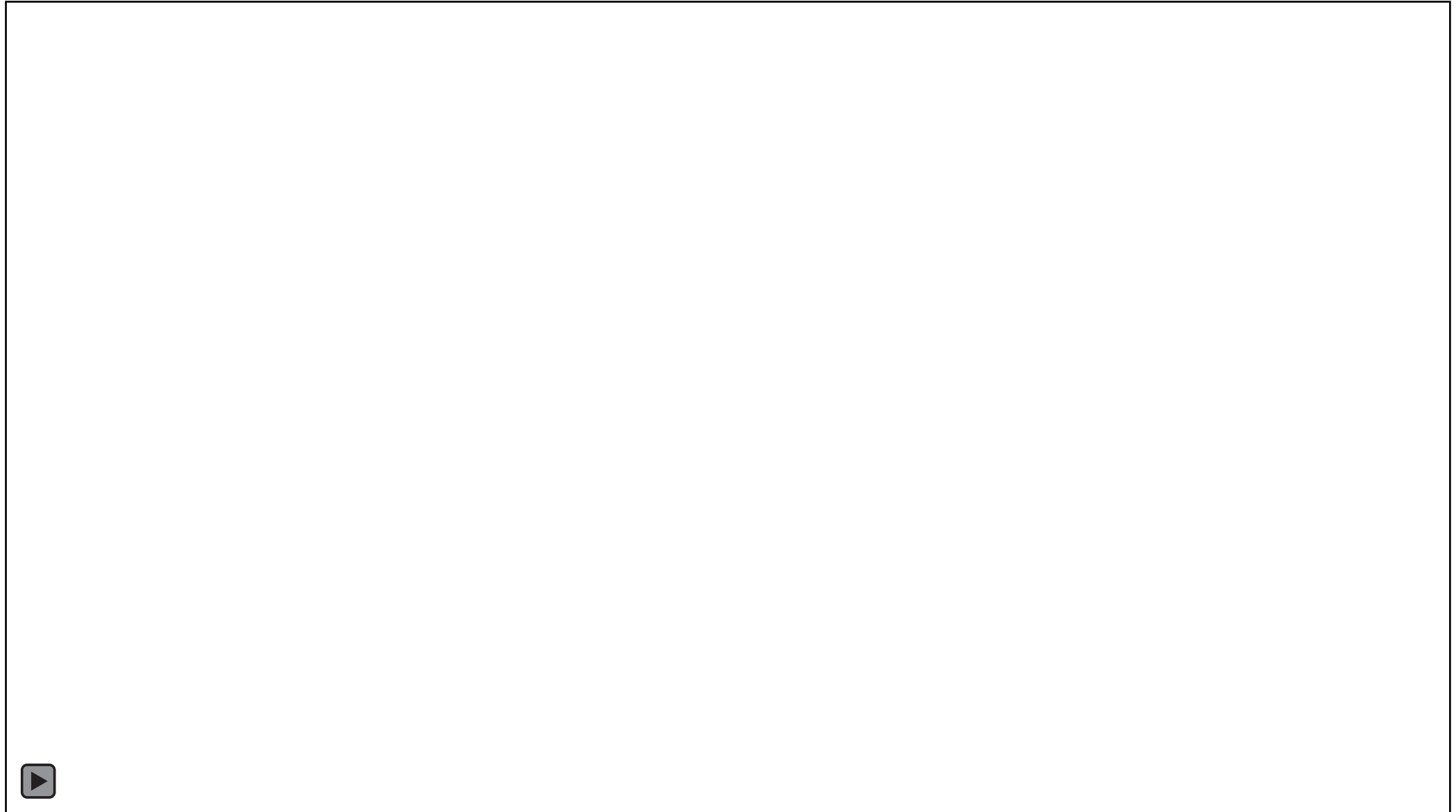


# El Modelo “Landslide Hazard Assessment for Situational Awareness” (LHASA)

Versión 1.1



# IMERG: Integrated Multi-satellitE Retrievals for GPM





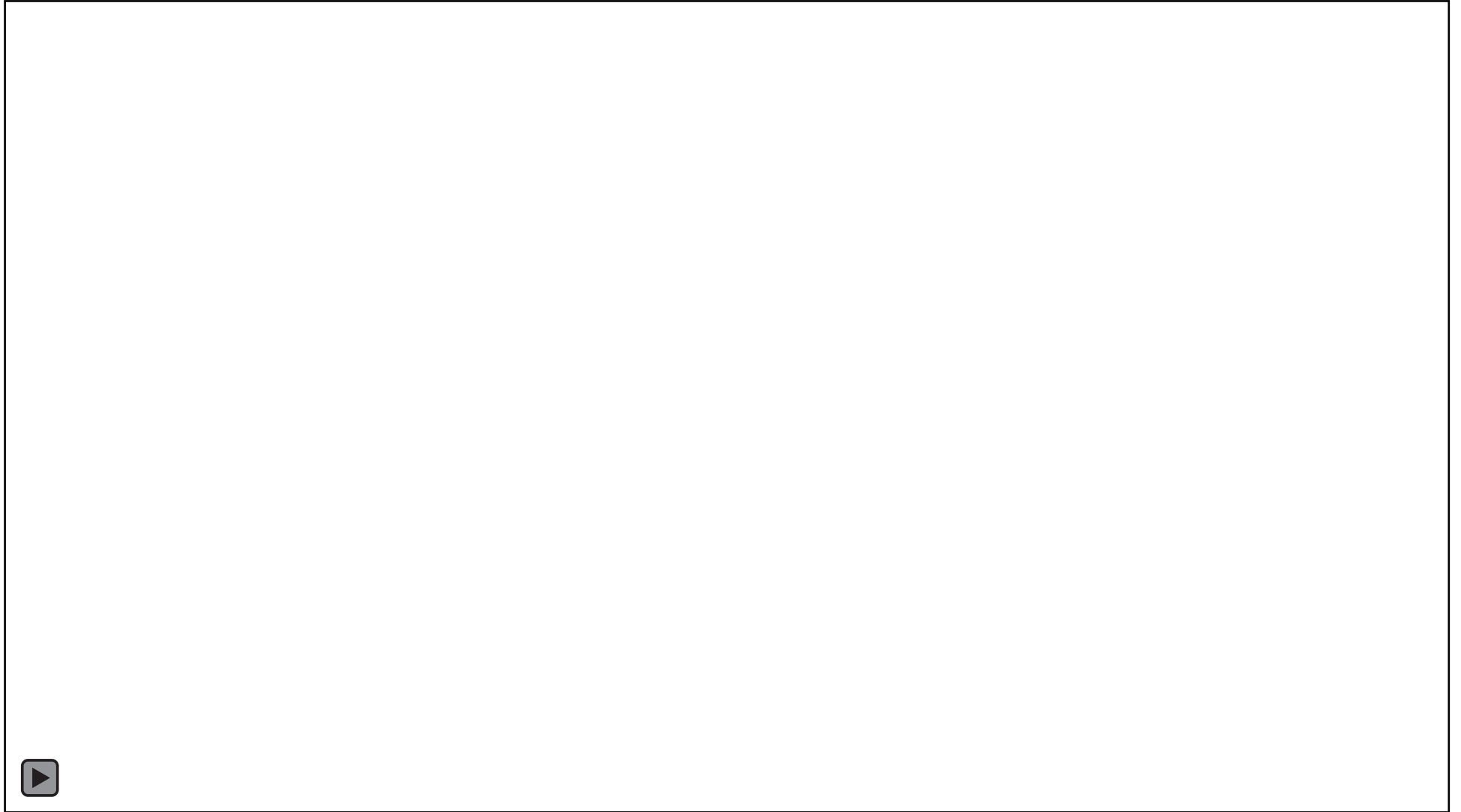
# Salida de LHASA para el Huracán Willa, 2018

Versión 1.1



# El Modelo “Landslide Hazard Assessment for Situational Awareness (LHASA)”

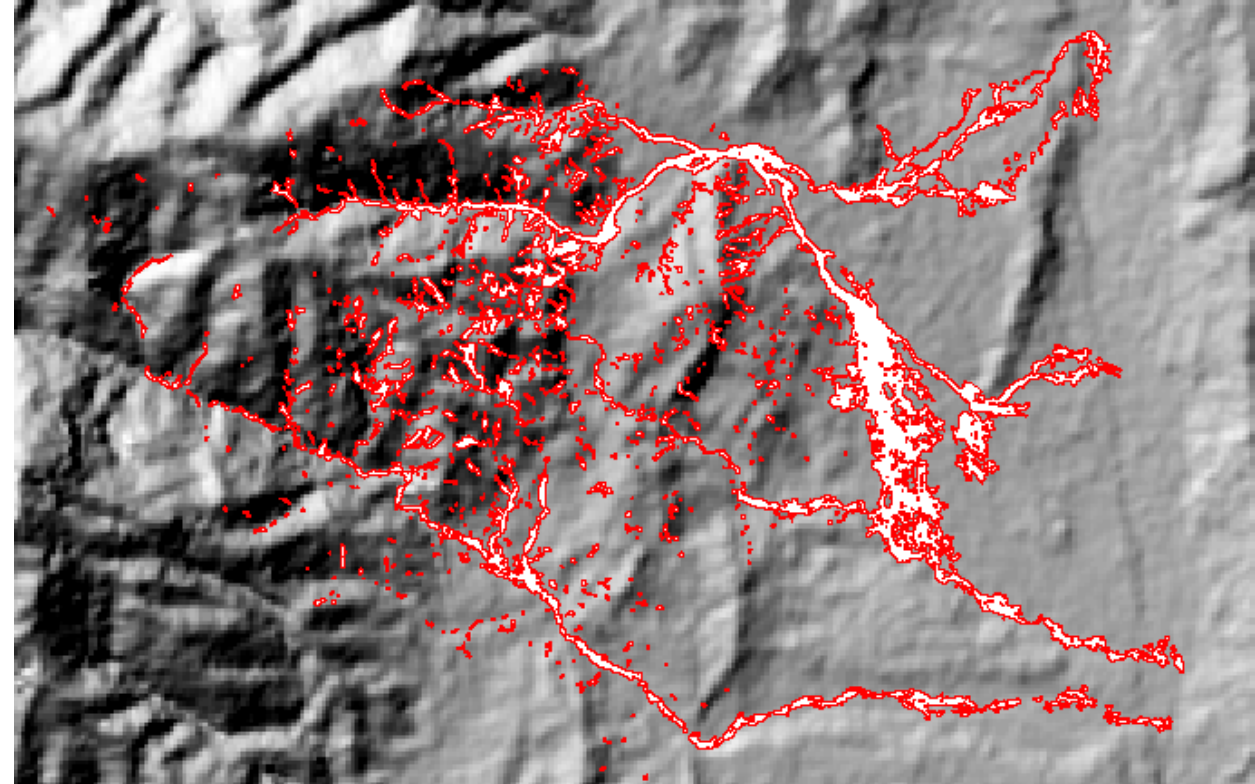
Versión 1.1





# El Modelo “Landslide Hazard Assessment for Situational Awareness” (LHASA)

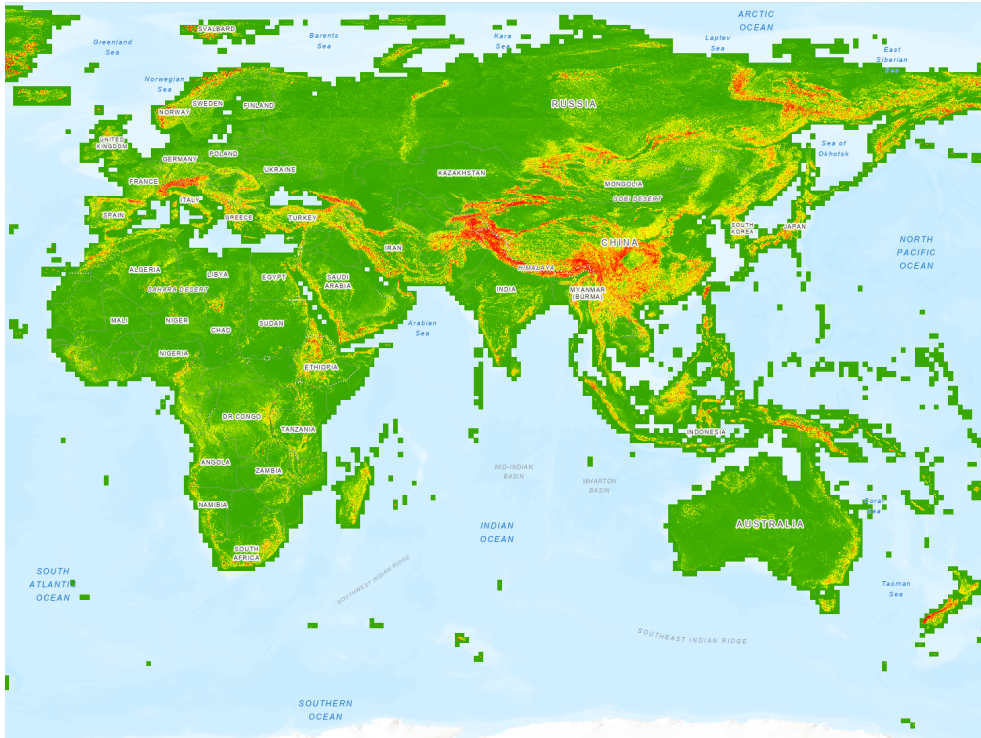
Versión 2.0





# El Modelo “Landslide Hazard Assessment for Situational Awareness” (LHASA)

Versión 2.0



Gradiente de Pendiente

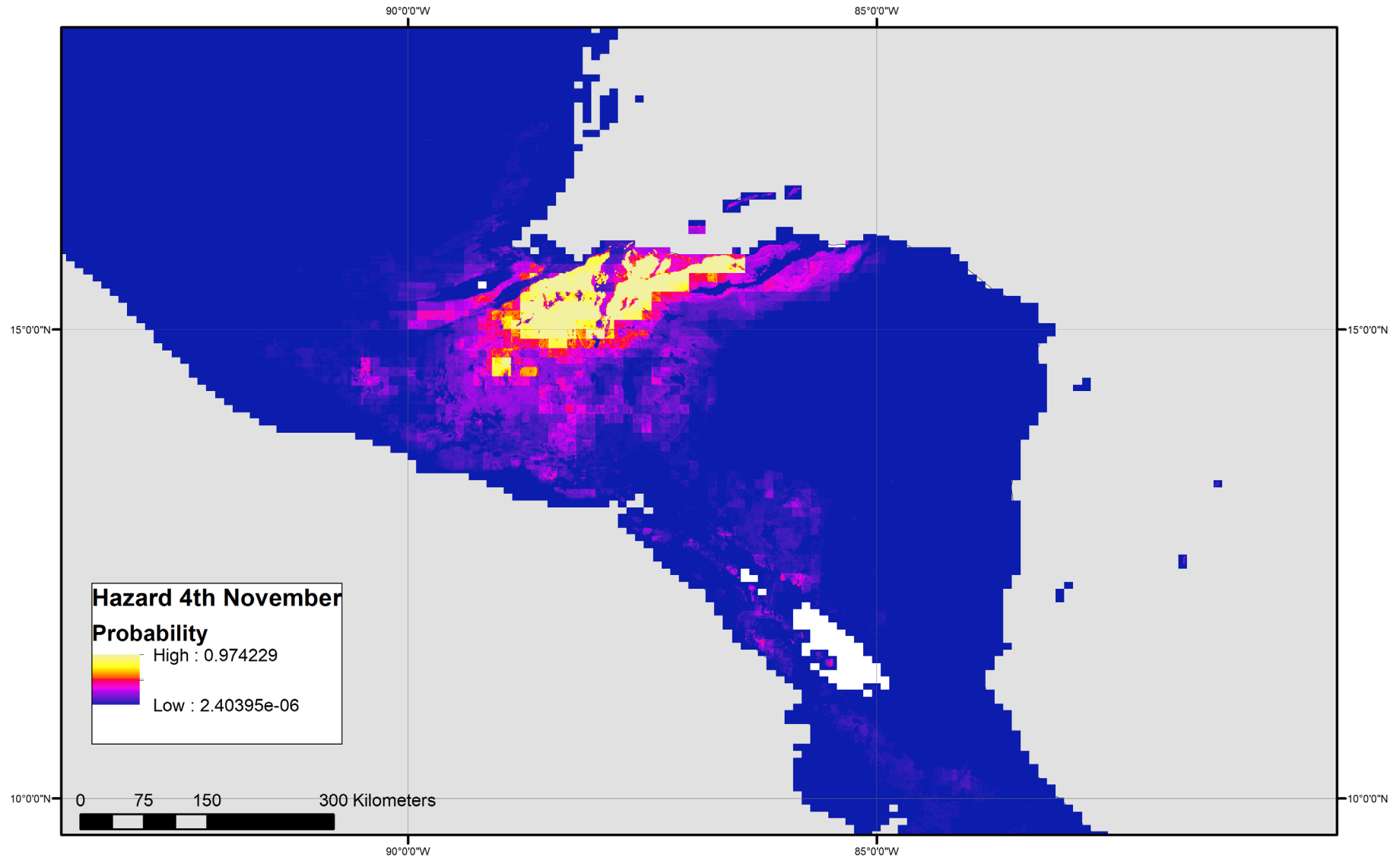


Distancia hasta una Falla



# El Modelo “Landslide Hazard Assessment for Situational Awareness”

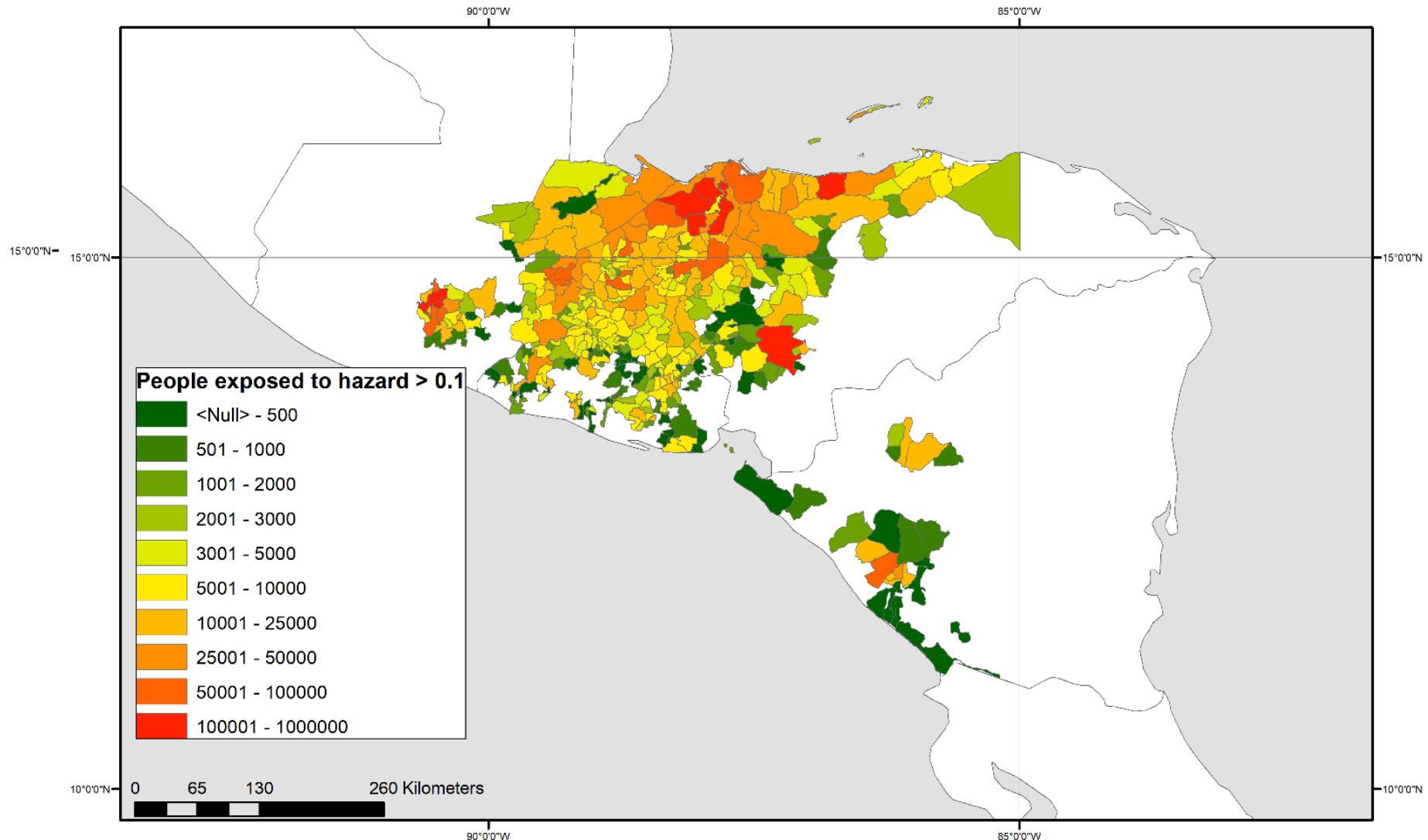
Versión 2.0





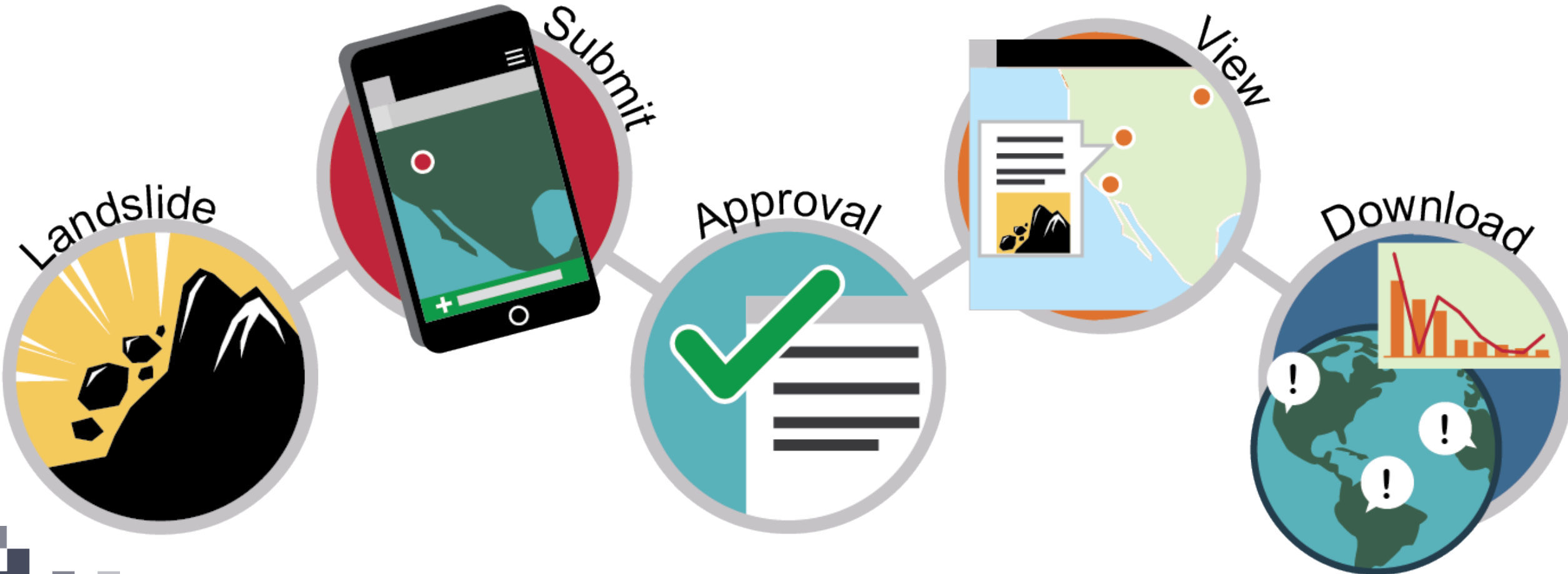
# El Modelo “Landslide Hazard Assessment for Situational Awareness”

Versión 2.0



# Informar sobre Derrumbes Después de un Evento

En Landslide Reporter ([landslides.nasa.gov/reporter](https://landslides.nasa.gov/reporter))



# ¿Para Qué Informar sobre Derrumbes?



En Landslide Reporter ([landslides.nasa.gov/reporter](https://landslides.nasa.gov/reporter))

## Beneficios para la Ciencia:

- Utilizamos estos datos para evaluar el nowcast y otros modelos.
- Ayuda a cuantificar los impactos de los derrumbes que actualmente se informan por de bajo de la realidad
- Llena los vacíos en nuestro conocimiento causados por sesgos en otros inventarios de derrumbes como GLC
  - Esto podría llevar a una distribución más justa de los esfuerzos de investigación y mitigación a los lugares que más lo necesitan.

## Beneficios para Su Comunidad:

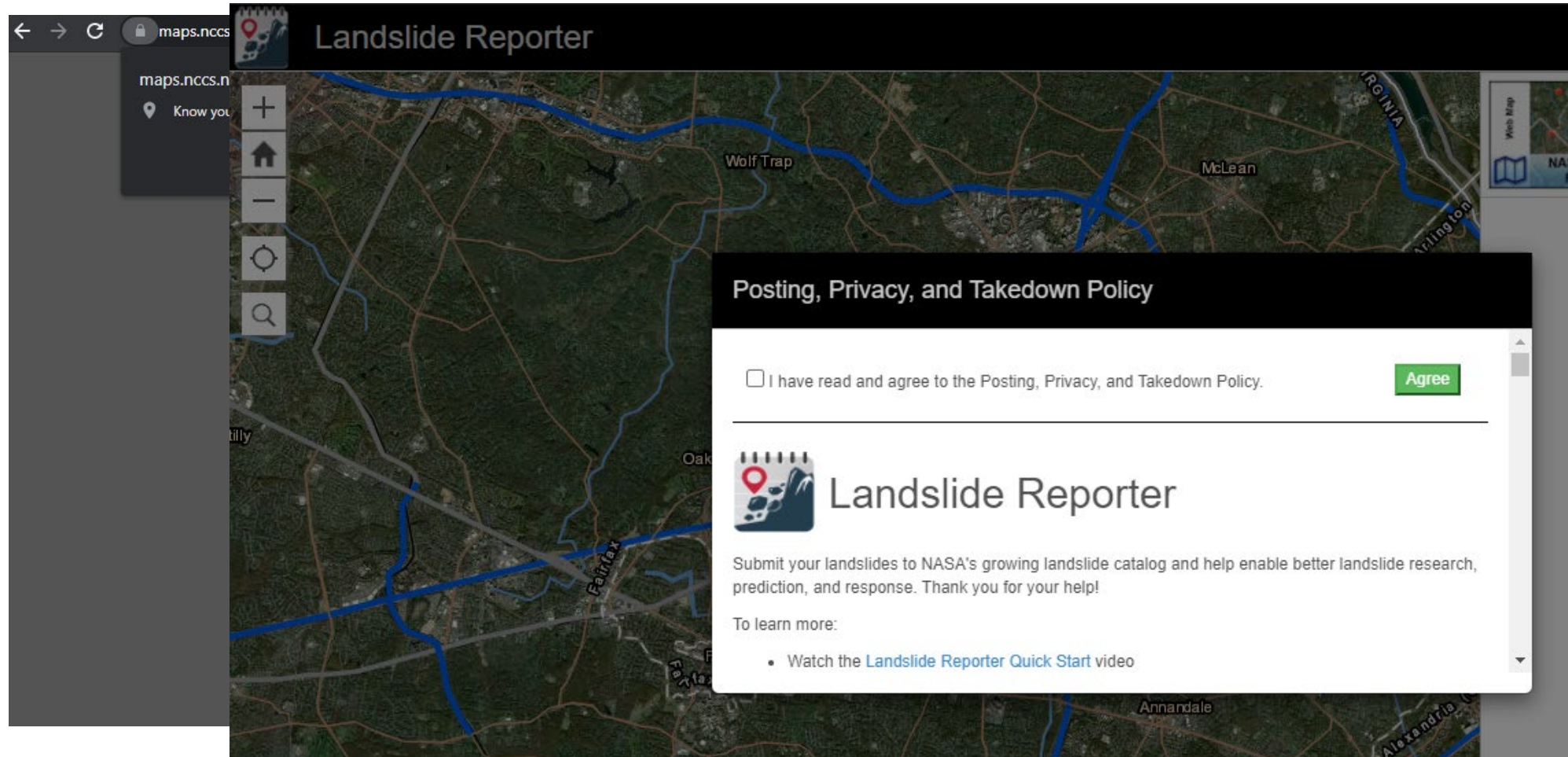
- Atrae la atención mundial sobre su trabajo en la reducción del riesgo de desastres.
- Puede ser una herramienta para educar a los ciudadanos sobre el peligro de derrumbes.
- Ayuda a mejorar la precisión de los modelos de derrumbes en su área
- Fomenta el intercambio de datos entre otras partes interesadas
- Puede proporcionar la justificación para futuras solicitudes de financiación.
- ¡No necesitas crear tu propia aplicación para hacer lo mismo!





# Informar sobre Derrumbes Después de un Evento

En Landslide Reporter ([landslides.nasa.gov/reporter](https://landslides.nasa.gov/reporter))



maps.nccs

## Landslide Reporter

Posting, Privacy, and Takedown Policy

I have read and agree to the Posting, Privacy, and Takedown Policy. [Agree](#)

### Landslide Reporter

Submit your landslides to NASA's growing landslide catalog and help enable better landslide research, prediction, and response. Thank you for your help!

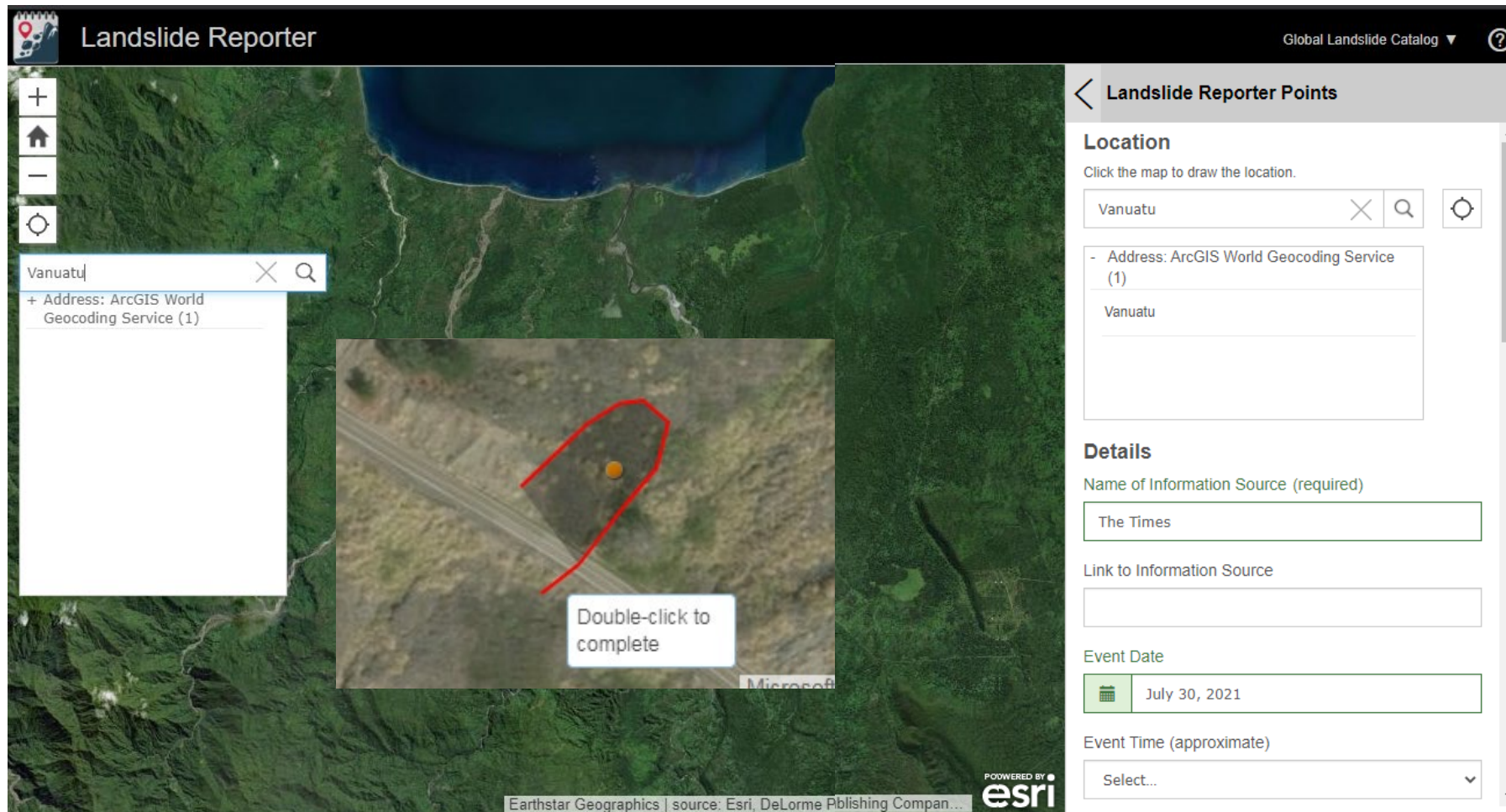
To learn more:

- Watch the [Landslide Reporter Quick Start video](#)



# Informar sobre Derrumbes Después de un Evento

En Landslide Reporter ([landslides.nasa.gov/reporter](https://landslides.nasa.gov/reporter))



**Landslide Reporter** Global Landslide Catalog

**Landslide Reporter Points**

**Location**  
Click the map to draw the location.  
Vanuatu  
- Address: ArcGIS World Geocoding Service (1)  
Vanuatu

**Details**  
Name of Information Source (required)  
The Times  
Link to Information Source  
Event Date  
July 30, 2021  
Event Time (approximate)  
Select...

Double-click to complete

POWERED BY esri

Earthstar Geographics | source: Esri, DeLorme Publishing Compan...





# Informar sobre Derrumbes Después de un Evento



En [landslides.nasa.gov](https://landslides.nasa.gov)

LANDSLIDES @ NASA

About How to Report Data Resources Policies

Reporter

Viewer

## Short Guides

This short 2-page guide will help you you read the [how-to guides](#) below to scientists.

**\*\*Please note**, guides in other language. These guides have not been cleaned accuracy of the translations.



### Landslide Reporter

Very short introduction to how to contribute landslide reports.

### Volunteer Translations

- **Arabic** ( العربية الارضية )
- **Bengali** ( বাংলা সম্পর্কিত এবং )
- **Czech** ( čeština )
- **Gujarati** ( ગુજરાતી બનાવી શકીએ )
- **Hindi** ( हिंदी निर्माण कर सकते हैं )
- **Italian** ( Italiano ) [Landslide Reporter: Reporter delle Frane](#)







## Estudio de Caso- Río de Janeiro

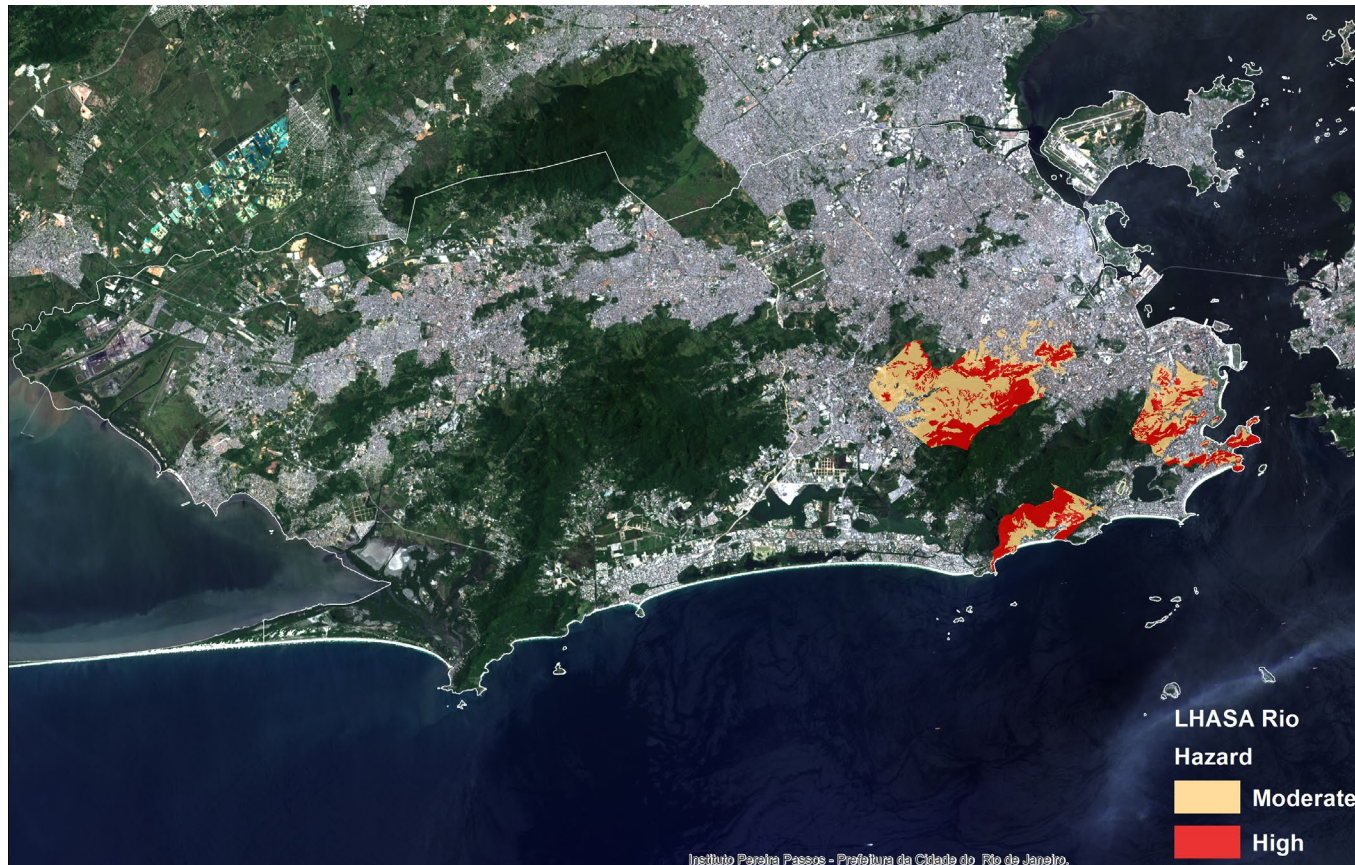


# LHASA-Rio 1.0





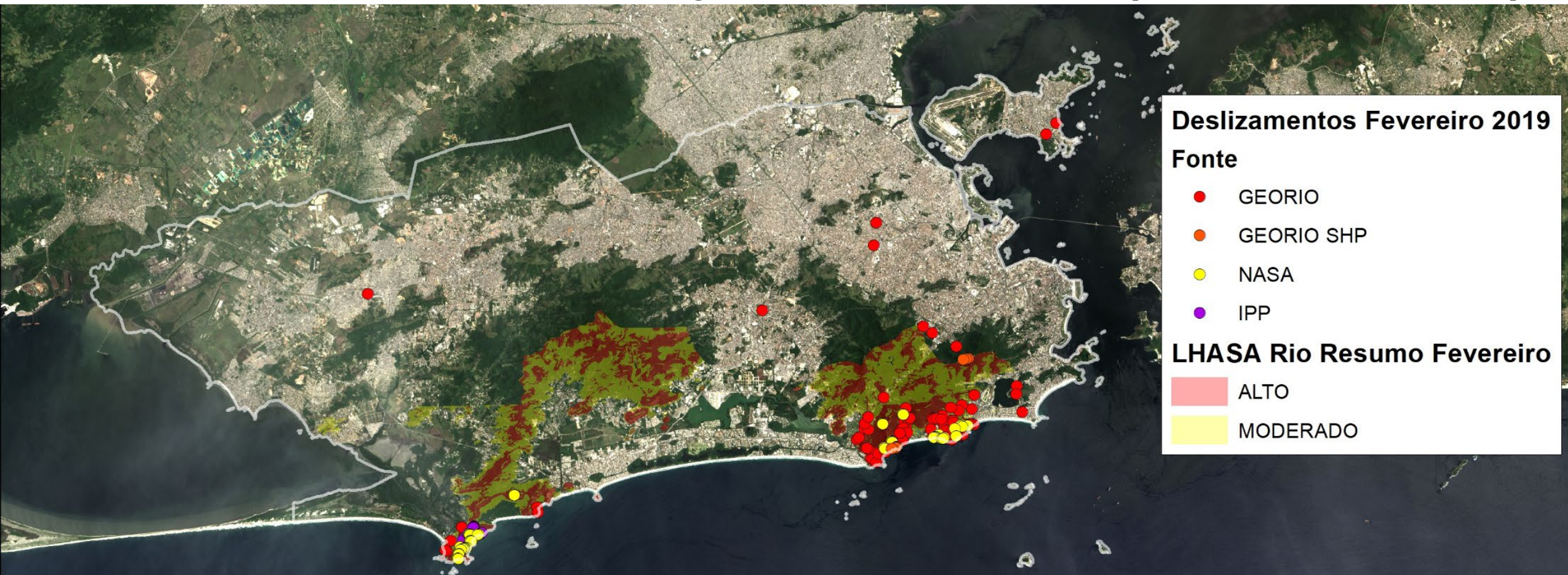
# LHASA-Rio 1.0





# LHASA-Rio 1.0

169 derrumbes mapeados, 156 áreas de peligro detectadas por LHASA Rio (Tasa de éxito de un 92,3%).



Fuentes de Datos: LHASA Rio, Geo-Rio, NASA e IPP (imágenes de alta resolución)  
Diapositiva cortesía de Felipe C. Mandarino, Río de Janeiro



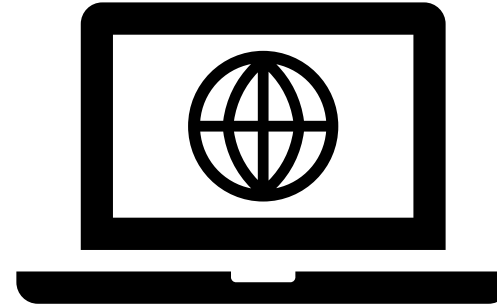




Comenzar con LHASA Versión 1.1

# Lo Que Necesita para Ejecutar LHASA Versión 1.1

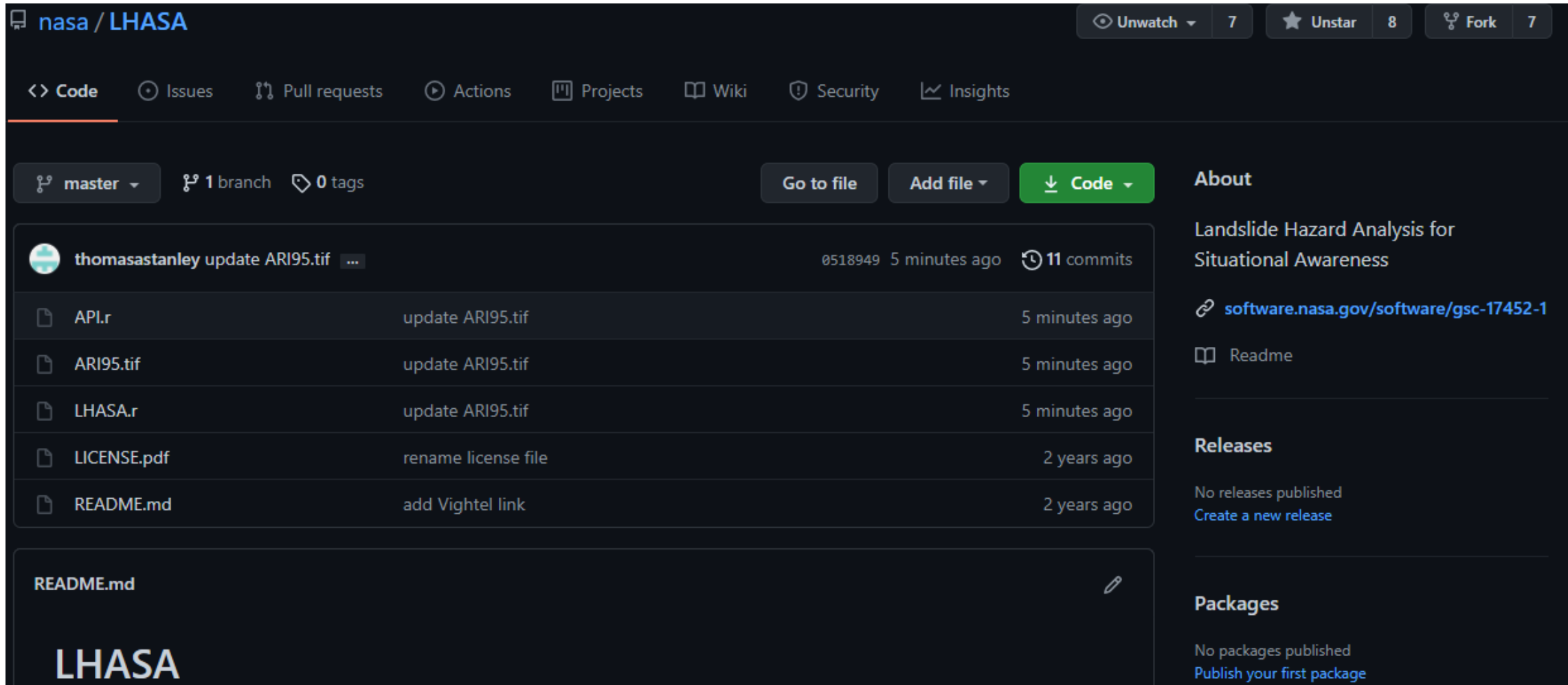
- Una computadora con el sistema de Windows
  - (LHASA funciona en otros sistemas, pero la apariencia y otros atributos son diferentes a los que se ven aquí.)
- Una conexión a internet
- El software para estadísticas R
  - Descargar aquí <https://cloud.r-project.org/>
  - (Es gratis.)





# Comenzar con LHASA Versión 1.1

Paso No. 1: Descargar el código de <https://github.com/nasa/LHASA>



nasa / LHASA

Unwatch 7 Unstar 8 Fork 7

Code Issues Pull requests Actions Projects Wiki Security Insights

master 1 branch 0 tags

Go to file Add file Code

thomasastanley update ARI95.tif ... 0518949 5 minutes ago 11 commits

API.r	update ARI95.tif	5 minutes ago
ARI95.tif	update ARI95.tif	5 minutes ago
LHASA.r	update ARI95.tif	5 minutes ago
LICENSE.pdf	rename license file	2 years ago
README.md	add Vightel link	2 years ago

README.md

# LHASA

About

Landslide Hazard Analysis for Situational Awareness

[software.nasa.gov/software/gsc-17452-1](https://software.nasa.gov/software/gsc-17452-1)

Readme

Releases

No releases published  
[Create a new release](#)

Packages

No packages published  
[Publish your first package](#)



# Comenzar con LHASA Versión 1.1

## Paso No. 2: Descargar el mapa global de susceptibilidad a derrumbes de:

<https://gpm.nasa.gov/sites/default/files/downloads/global-landslide-susceptibility-map-1-30-20.zip>

○ use su propio mapa de susceptibilidad (en formato GeoTIFF)

GLOBAL PRECIPITATION MEASUREMENT

Missions Data Applications Science Resources Education

This video is public domain and can be downloaded at: <http://svs.gsfc.nasa.gov/goto?11091>;

Read More

improve predic

- Landslide R
- Landslide V
- Landslide R

Twitter

loads > LHASA-master > global-landslide-susceptibility-map-1-30-20

Name	Date modified	Type	Size
suscV1_1.tfw	1/30/2020 8:53 AM	TFW File	1 KB
suscV1_1.tif	1/30/2020 8:53 AM	TIF File	32,254 KB
suscV1_1.tif.aux.xml	1/30/2020 8:53 AM	XML Document	2 KB
suscV1_1.tif.vat.cpg	1/30/2020 8:53 AM	CPG File	1 KB
suscV1_1.tif.vat.dbf	1/30/2020 8:53 AM	DBF File	1 KB
suscV1_1.tif.xml	1/30/2020 8:59 AM	XML Document	1 KB

LHASA) model was wide range of users. The landslide susceptibility maps are likely to o

ative Open On

lobal Landslide C

Landslide Repo

Open link in new tab

Open link in new window

Open link in incognito window

Save link as...

Copy link address

Inspect Ctrl+Shift+I

For more information on global landslide inventories and NASA's landslide modeling activities please visit <https://landslides.nasa.gov>

Further reading on the model structure and evaluation is available at: <https://landslides.nasa.gov/resources.html>

Please cite the following publications when using this information:

<https://gpm.nasa.gov/sites/default/files/downloads/global-landslide-susceptibility-map-1-30-20.zip>



# Comenzar con LHASA Versión 1.1

## Paso No. 3: Descargar los datos de IMERG de <https://gpm.nasa.gov/data/imerg>

### 1 Day IMERG Late Run Precipitation Accumulations in GeoTIFF format

- **Download URL:** <https://jsimpsonhttps.pps.eosdis.nasa.gov/imerg/gis/>
- Longer latency than Early Run but a higher quality product.
- [Click here to register for the PPS FTP](#)
- [Read documentation for using IMERG GeoTIFF + Wordfiles](#)
- Files located in `./[yyyy]/[mm]`
- 30 minute, 3 hour, 1 day, 7 day, and 1 month files are all available in the same directory, with the timespan indicated within the filename (e.g. 3B-HHR-L.MS.MRG.3IMERG.20200516-S083000-E085959.0510.V06B.3hr.tif is a 3 hour file)
- 1 month files are located in the folder corresponding to the first day of each month.
- Precipitation values are scaled by a factor of x10 (0.1mm) for 30 minute, 3 hour, 1 day, 3 day and 7 day files, and are scaled by a factor of x1 (1mm) for 1 month files.

1 Day IMERG Late Run Precipitation Accumulations in GeoTIFF format

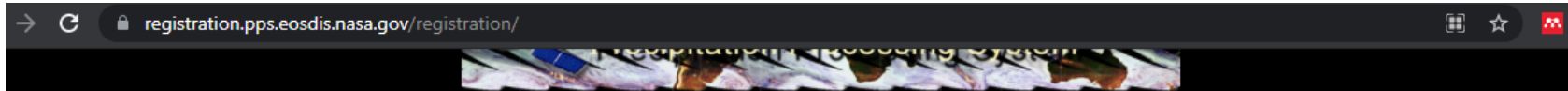
1 Month IMERG Final Run Precipitation Accumulations in GeoTIFF format





# Comenzar con LHASA Versión 1.1

## Paso No. 3a: Registrarse en el NASA Precipitation Processing System (PPS)



### PPS Registration

Click on "**Register**" to get access to PPS Products.

Fill out the form and click on "Save".

You will get a confirmation e-mail and use it to complete the process.

If you don't receive this e-mail in one hour, please check in your spam folder, and then contact [helpdesk@mail.pps.eosdis.nasa.gov](mailto:helpdesk@mail.pps.eosdis.nasa.gov) to resolve the issue.

Once you are registered, you can edit your information by entering in your email address (below) and clicking on "Verify Email or Update Info". Please follow the instructions contained in the automated email to complete the process.

Please note that by registering to get access to GPM data through PPS, you are also agreeing to receive emails from PPS informing you of system and product status. If you do not wish to receive system status emails then please do not register for access to PPS.

We do not accept email addresses that require us to take a manual action (Boxbe, etc.). Please do not use a university address that is a reflector to gmail but use the direct gmail address instead.

If you plan to use Near-Real Time (NRT) data stored on [jsimpsonftp.pps.eosdis.nasa.gov](https://jsimpsonftp.pps.eosdis.nasa.gov), make sure to check the box stating that you are interested in NRT products. Otherwise, your account will only allow access to production data on [arthurhou.pps.eosdis.nasa.gov](https://arthurhou.pps.eosdis.nasa.gov). However, if you do not need to use NRT products, please do not register for NRT access. You can add/remove NRT access using the "Verify Email or Update Info" tool.

Please note that your Email will be converted to lower case. Once registration is completed use this email address in lower case as both your User Name and Password to retrieve data from our FTP archives or place orders through STORM.

NEVER reply to an email that is sent to you. If you have questions, please contact [helpdesk@mail.pps.eosdis.nasa.gov](mailto:helpdesk@mail.pps.eosdis.nasa.gov).

### Register

OR

Enter registered email:

Verify Email or Update Info

Remove from access to PPS

<https://registration.pps.eosdis.nasa.gov/registration/>



# Comenzar con LHASA Versión 1.1

## Paso No. 3b: Descargar IMERG

### Index of /imerg/gis/2004/08

Name	Last modified	Size	Description
10/	2021-07-27 15:30	-	
11/	2021-07-27 15:30	-	
12/	2021-07-27 15:40	-	
2000/	2019-08-19 14:52	-	
2001/	2019-08-20 12:40	-	
2002/	2019-08-22 11:43	-	
2003/	2019-08-22 15:12	-	
2004/	2019-08-23 09:48	-	
2005/	2019-08-23 22:53	-	
2006/			
Parent Directory			
01/	2019-08-22 15:50	-	
02/	2019-08-22 16:03	-	
03/	2019-08-22 16:34	-	
04/	2019-08-22 16:46	-	
05/	2019-08-22 17:08	-	
06/	2019-08-22 17:21	-	
07/	2019-08-22 17:37	-	
3B-DAY-L.GIS.IMERG.2..>	2019-08-18 17:44	6.4M	
3B-DAY-L.GIS.IMERG.2..>	2019-08-18 17:47	6.4M	
3B-DAY-L.GIS.IMERG.2..>	2019-08-18 17:50	6.7M	
3B-DAY-L.GIS.IMERG.2..>	2019-08-18 17:53	6.8M	
3B-DAY-L.GIS.IMERG.2..>	2019-08-18 17:56	6.7M	
3B-DAY-L.GIS.IMERG.2..>	2019-08-18 17:59	6.5M	
3B-DAY-L.GIS.IMERG.2..>	2019-08-18 18:02	6.6M	
3B-DAY-L.GIS.IMERG.2..>	2019-08-18 18:20	6.5M	
3B-DAY-L.GIS.IMERG.2..>	2019-08-18 18:23	6.7M	
3B-DAY-L.GIS.IMERG.2..>	2019-08-18 18:26	6.6M	
3B-DAY-L.GIS.IMERG.2..>	2019-08-18 18:29	6.6M	



# Comenzar con LHASA Versión 1.1

## Paso No. 3c: Extraer archivos de datos de lluvias

The screenshot displays two overlapping File Explorer windows. The primary window is titled 'Extract' and shows the contents of the zip file '3B-DAY-L.GIS.IMERG.20040801.V06B.zip'. The secondary window is titled 'IMERG' and shows the contents of the 'IMERG' folder, including the extracted zip file and other files.

Name	Type
3B-DAY-L.GIS.IMERG.20040801.V06B.ice.tfw	TFW File
3B-DAY-L.GIS.IMERG.20040801.V06B.ice.tif	TIF File
3B-DAY-L.GIS.IMERG.20040801.V06B.liquid.tfw	TFW File
3B-DAY-L.GIS.IMERG.20040801.V06B.liquid.tif	TIF File
3B-DAY-L.GIS.IMERG.20040801.V06B.liquidPercent.tfw	TFW File
3B-DAY-L.GIS.IMERG.20040801.V06B.liquidPercent.tif	TIF File
3B-DAY-L.GIS.IMERG.20040801.V06B.tfw	TFW File
3B-DAY-L.GIS.IMERG.20040801.V06B.tif	TIF File
DOI.txt	Text Document

Name	Date modified	Type	Size
3B-DAY-L.GIS.IMERG.20040801.V06B.liquid.tif	8/18/2019 1:44 PM	TIF File	2,979 KB
3B-DAY-L.GIS.IMERG.20040801.V06B.zip	8/1/2021 9:21 PM	Compressed (zipp...	6,509 KB





# Comenzar con LHASA Versión 1.1

## Paso No. 4: Calcular el Índice de Precipitación Antecedente

RGui (64-bit) - [C:\Users\tastanle\Downloads\LHASA-master\API.r - R Editor]

File Edit Packages Windows Help



```
# 7-day ARI calculation v1.1.1
# 2021-8-2
# Thomas Stanley NASA
# Calculates a 7-day
```

```
# Load R packages
library(raster)
```

```
# Set working directory
setwd('C:/LHASA')
```

```
files <- list.files('C:/LHASA')
```

```
# Set antecedent rainfall window
ARI.window <- 7
# Set IDW exponent
exponent <- 2
```

```
# Calculate weights
```

```
w <- 1/seq(ARI.window, 1)^exponent
```

```
# Iterate through every day, starting at the end of the 1st ARI window
```

```
for(day in ARI.window:length(files)){
```

```
  # Open files within window, including current day
```

```
  IMERG <- crop(stack(files[(day - ARI.window + 1):day]), extent(-180, 180, -60, 60))
```

```
  # Calculate antecedent rainfall index
```

```
  ARI <- calc(w*IMERG, sum)/sum(w)
```

```
  # Save to disk
```

```
  writeRaster(ARI, filename=gsub('IMERG/', 'ARI/', files[day]))
```

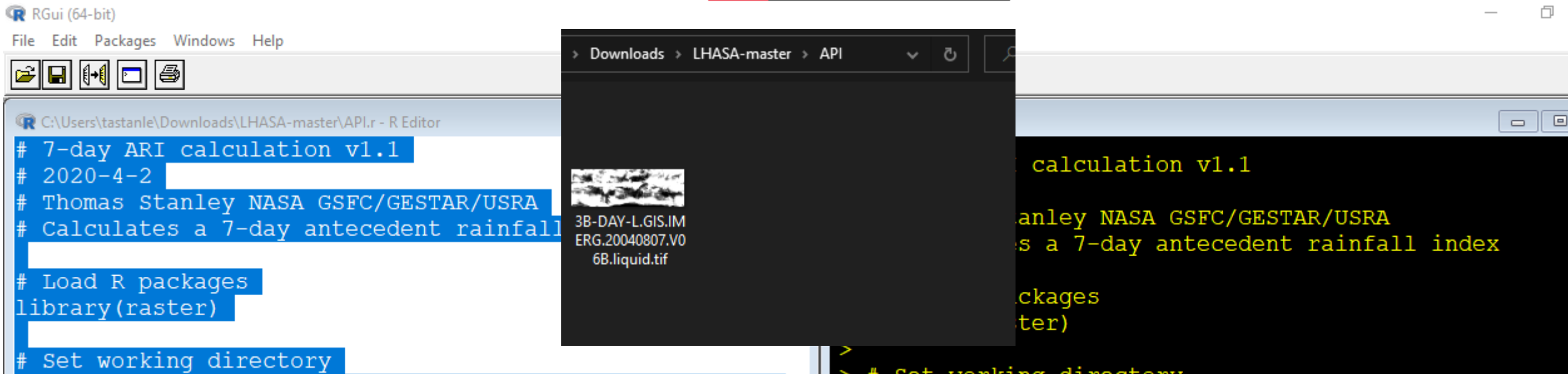
```
}
```

Name	Date modified	Type	Size
API	8/2/2021 10:53 AM	File folder	
global-landslide-susceptibility-map-1-30...	8/1/2021 4:42 PM	File folder	
IMERG	8/2/2021 10:34 AM	File folder	
API.r	1/12/2021 8:20 PM	R File	1 KB
ARI95.tif	1/12/2021 8:20 PM	TIF File	24,122 KB
LHASA.r	1/12/2021 8:20 PM	R File	2 KB
LICENSE.pdf	1/12/2021 8:20 PM	Adobe Acrobat D...	132 KB
README.md	1/12/2021 8:20 PM	MD File	1 KB



# Comenzar con LHASA Versión 1.1

## Paso No. 4: Calcular el Índice de Precipitación Antecedente



```
File Edit Packages Windows Help
C:\Users\tastanle\Downloads\LHASA-master\API.r - R Editor
# 7-day ARI calculation v1.1
# 2020-4-2
# Thomas Stanley NASA GSFC/GESTAR/USRA
# Calculates a 7-day antecedent rainfall index
# Load R packages
library(raster)
# Set working directory
```

Downloads > LHASA-master > API

3B-DAY-L.GIS.IM.ERG.20040807.V0.6B.liquid.tif

```
calculation v1.1
Thomas Stanley NASA GSFC/GESTAR/USRA
Calculates a 7-day antecedent rainfall index
Load R packages
library(raster)
# Set working directory
```



# Comenzar con LHASA Versión 1.1

## Paso No. 4: Ejecutar el modelo LHASA

RGui (64-bit) - [C:\Users\tastanle\Downloads\LHASA-master\LHASA.r - R Editor]

File Edit Packages Windows Help



```
# NASA Goddard Space Flight Center
# Maps the potential for landslides by identifying which locations
# exceed thresholds for a 7-day antecedent precipitation index
# and a landslide susceptibility map.

# Load packages

# Set working directory
setwd('C:/LHASA')

# Open antecedent rainfall threshold file
# Note that the version of this file posted at https://github
# is based on the use of daily geotiff files, which are in te
# To use with the netcdf version of IMERG, divide by 10.
threshold <- crop(raster('ARI95.tif'), extent(100, 100, 0,
# Open the susceptibility map
susceptible <- crop(raster('global.tif'), extent(-180, 180, -
files <- list.files(path='ARI', pattern='*.tif', full.names=T

# Iterate through all days in record
for(f in files){
  # Open antecedent rainfall index file for current date
  ARI <- raster(f)
  # Compare to ARI threshold
  wet <- ARI > threshold
  # Run decision tree model at resolution of susceptibility map
  moderate <- resample(wet, susceptible, method='ngb') & (susceptible > 2)
  high <- moderate & (susceptible > 4)

  # Save outputs
  writeRaster(nowcast, filename=gsub('ARI/', 'nowcast/', f), datatype='INT1U')
}
```

Name	Date modified	Type	Size
ARI	8/2/2021 10:02 PM	File folder	
IMERG	8/2/2021 5:23 PM	File folder	
nowcast	8/2/2021 10:02 PM	File folder	
API.r	8/2/2021 10:01 PM	R File	1 KB
ARI95.tif	8/2/2021 10:01 PM	TIF File	23,234 KB
global.tif	8/2/2021 4:44 PM	TIF File	32,583 KB
LHASA.r	8/2/2021 10:01 PM	R File	2 KB
LICENSE.pdf	8/2/2021 10:01 PM	Adobe Acrobat D...	132 KB
README.md	8/2/2021 10:01 PM	MD File	1 KB





# Comenzar con LHASA Versión 1.1

## Paso No. 4: Ejecutar el Modelo LHASA

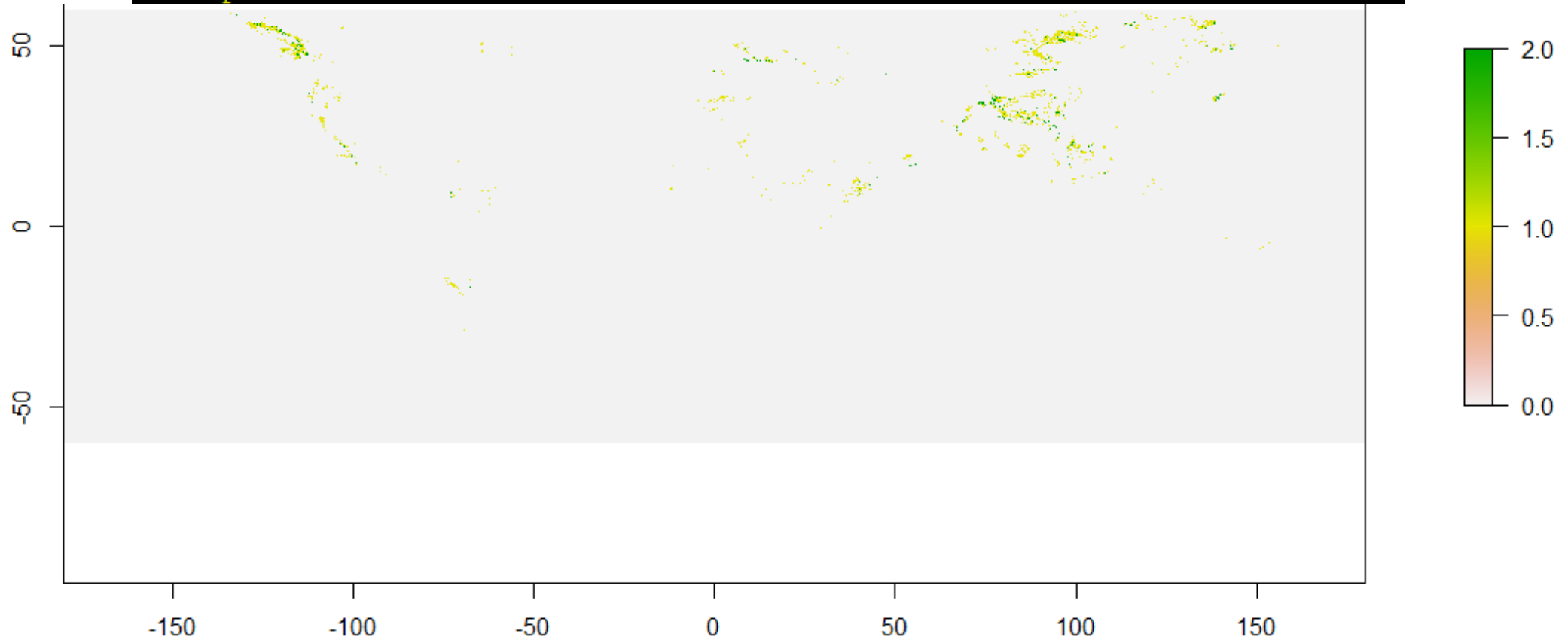
```
> # Landslide Hazard Assessment for Situational Awareness, version 1.1.1
> # By Thomas Stanley USRA/GESTAR 2021-8-2
> # NASA Goddard Space Flight Center
> # Maps the potential for landslides by identifying which locations
> # exceed thresholds for a 7-day antecedent precipitation index
> # and a landslide susceptibility map.
>
> # Load packages
> library(raster)
> # Set working directory
> setwd('C:/Users/tastanle/Downloads/LHASA-master')
>
> # Open antecedent rainfall threshold file
> # Note that the version of this file posted at https://github.com/nasa/LHASA
> # is based on the use of daily geotiff files, which are in tenths of mm.
> # To use with the netcdf version of IMERG, divide by 10.
> threshold <- crop(raster('ARI95.tif'), extent(-180, 180, -60, 60))
> # Open the susceptibility map
> susceptible <- crop(raster('global.tif'), extent(-180, 180, -60, 60))
```



# Comenzar con LHASA Versión 1.1

## Paso No. 5: Visualizar el Nowcast

```
> for(f in files){  
+ # Open antecedent rainfall index file for current date
```



# Los Sigüientes Pasos con LHASA Versión 1.1

## Cómo hacer que funcione mejor para su isla:

1. Evalúe el rendimiento histórico del modelo
  - ¿Logró pronosticar derrumbes exitosamente?
  - ¿Hubo algún tipo de derrumbe o tormenta para el cual no funcionó muy bien?
  - ¿Hay alguna parte de la isla donde funciona con mayor exactitud?
2. Aumente o reduzca el umbral de lluvia o el umbral de susceptibilidad
3. Remplace el mapa de susceptibilidad global con uno nacional
4. Remplace IMERG con un conjunto de datos de lluvias de alta resolución de radar, pluviómetros o modelos





# Repaso

## Evaluación del Peligro de Derrumbes en Pequeños Estados Insulares

- La información sobre los derrumbes puede ser útil durante todas las etapas del ciclo vital de los desastres.
- La NASA tiene varios recursos en línea:
  - Landslide Viewer
  - Landslide Reporter
- El modelo LHASA utiliza precipitación informada por IMERG para producir “pronósticos del presente” (nowcasts) a nivel mundial.
- Se puede implementar LHASA versión 1.1 con códigos y datos de fuente abierta.
  - Pero, se recomienda personalizarlo para su región.



# Referencias

- Stanley, T. A., D. B. Kirschbaum, G. Benz, et al. 2021. "Data-Driven Landslide Nowcasting at the Global Scale." *Frontiers in Earth Science*, 9: [10.3389/feart.2021.640043]
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- Stanley, T., and D. B. Kirschbaum. 2017. "A heuristic approach to global landslide susceptibility mapping." *Natural Hazards*, 1-20 [10.1007/s11069-017-2757-y]
- Kirschbaum, D. B., T. Stanley, and Y. Zhou. 2015. "Spatial and temporal analysis of a global landslide catalog." *Geomorphology*, 249 (Geohazard Databases): 4-15 [10.1016/j.geomorph.2015.03.016]
- Kirschbaum, D. B., R. F. Adler, Y. Hong, S. Hill, and A. Lerner-Lam. 2010. "A global landslide catalog for hazard applications: method, results, and limitations." *Natural Hazards* 52 (3): 561-575 [10.1007/s11069-009-9401-4]



# Tarea y Certificado

- Habrá una tarea asignada:
  - Debe enviar sus respuestas vía Formularios de Google, acceso desde la página web de ARSET [aquí](#).
  - La tarea estará disponible el 26 de agosto.
  - Fecha límite para entregar la tarea: 15 de septiembre de 2021
- Se otorgará un certificado de finalización de curso a quienes:
  - Asistan a todas las presentaciones en vivo
  - Completen la tarea asignada dentro del plazo estipulado
  - Recibirán sus certificados aproximadamente dos meses después de la conclusión del curso de: [marines.martins@ssaihq.com](mailto:marines.martins@ssaihq.com)





# Contactos

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Síguenos en Twitter  
[@NASAARSET](https://twitter.com/NASAARSET)

## Página Web de la Capacitación:

- <https://appliedsciences.nasa.gov/join-mission/training/english/arset-satellite-observations-analyzing-natural-hazards-small-island>

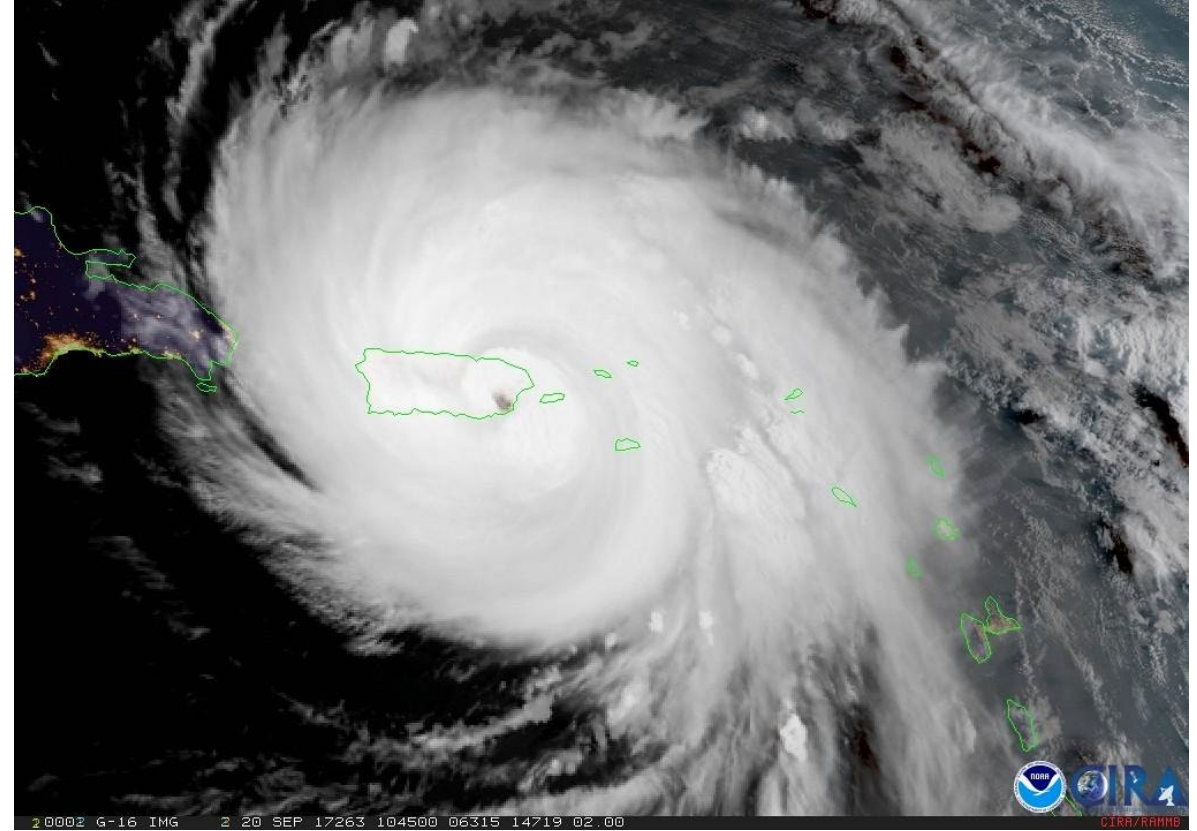
## Página Web de ARSET:

- <https://appliedsciences.nasa.gov/what-we-do/capacity-building/arset>



# Preguntas

- Por favor escriban sus preguntas en el cuadro para preguntas y respuestas. Las responderemos en el orden que las recibamos.
- Publicaremos las preguntas y respuestas a la página web de la capacitación después de la conclusión del webinar.



Fuente de la Imagen: [NOAA](#)



El material de esta presentación está basado en el trabajo de:

James Shute, Ryan Forbes, Neh Patel, Laura Carriere, Caroline Juang, Dalia Kirschbaum, Jack Simmons, Robert Emberson, Pukar Amatya, Garrett Benz, Marin Clark, William Medwedeff, Yaping Zhou, George Huffman y muchos, muchos otros.



**¡Gracias!**

Portal de computación  
en línea cortesía de:

